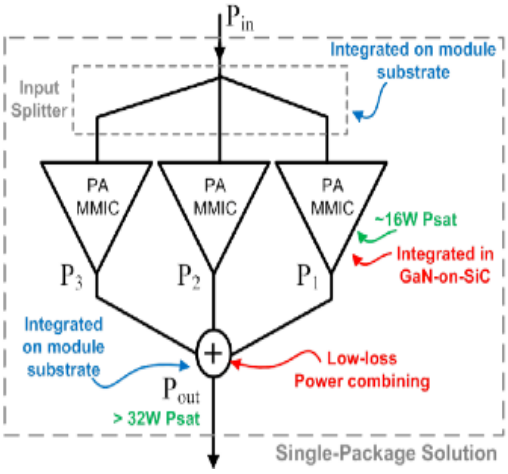
TECHNONOLOGIES UNDER DEVELOPMENT VIA JPL MANAGED PHASE I SBIR, SBIR SELECT & STTR CONTRACTS FOR 2015 – BY SUBTOPIC

- S1.02 Microwave Sensors for Remote Sensing
- S1.03 Sensor and Detector Technology for Visible, Far IR & Submillimeter
- S1.06 In Situ Sensors & Sensor Systems for Lunar and Planetary Science
- S1.08 Surface & Sub-surface Measurement Systems
- S1.09 Atomic Interferometry
- S1.10 Cryogenic Systems for Sensors & Detectors
- S2.01 Proximity Glare Suppression for Astronomical Coronagraphy
- S2.02 Precision Deployable Optical Structures & Metrology
- S3.06 Terrestrial & Planetary Balloons
- S3.07 Thermal Control Systems
- S4.01 Planetary Entry, Descent & Landing, and Small Body Proximity Operation Technology
- S4.02 Robotic Mobility, Manipulation & Sampling
- S4.03 Spacecraft Technology for Sample Return
- S4.04 Extreme Environments Technology
- S4.05 Contamination Control & Planetary Protection
- S5.04 Integrated Science Mission Modeling
- S5.05 Fault Management Technologies
- H1.01 Regolith ISRU for Mission Consumable Production
- H2.03 High Power Electric Propulsion
- H3.01 Environmental Monitoring for Spacecraft Cabins
- H9.01 Long Range Optical Communications
- Z1.02 Solid-State Thermal-to-Electric Power Generation
- Z6.01 Advanced Metallic Materials & Processes Innovation
- S20.01 Novel Spectroscopy Technology & Instrumentation
- T8.01 Technologies for Planetary Compositional Analysis & Mapping
- T11.02 Computational Simulation & Engineering

Microwave Sensing for Remote Sensing

Alphacore, Inc.



Innovation

Enables versatility and scalability to future scientific space applications, as well as radar and satellite communications applications that may operate in slightly modified frequency bands. The significance of the innovation is that a power amplifier with the above- listed specifications is currently not available.

Applications

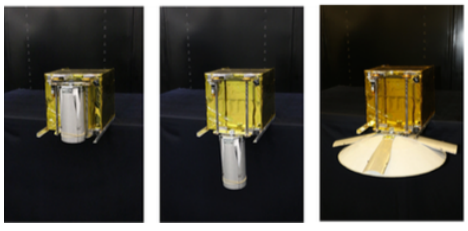
Examples of target missions are: CubeSats, GACM, CAMLS, A-SMLS, SOFIA and GUSSTO. Other NASA programs that can benefit from the technology are Europa Clipper, TSSM, VESPER, MARVEL, comet nucleus return, New Discovery, MAVEN and lunar orbiters and landers. Europa Clipper and Io Volcano Observer missions can greatly benefit from the very high radiation hardness. The planetary and small body lander missions (Mars, Titan, Moon, comets, asteroids) can benefit from the – 240° C capability.

Non-NASA Applications

Examples of military applications are Advanced Electronically Scanned Array (AESA) radar, electronic warfare (EW) systems and satellite communication systems. The defense space industry, including satellite programs of Air Force, NRO, MDA, and Army will greatly benefit from the power amplifier. Commercial LEO and GEO telecom satellites and weather/metrology applications will also benefit.

GATR Technologies

Innovation



The work of this SBIR will specifically address sol utions to the stowing, deployment, and environmental design challenges of producing an antenna module for CubeSats.

CubeSats equipped with large aperture antennas will transmit highly focused signals with increased link gain without drawing additional power from the spacecraft bus. Link bandwidth will be increased for communications and spatial resolution will be improved for radiometry.

Applications

Earth Observation Satellites in low Earth orbits, especially modular CubeSats, are opportunities. This means an equally diverse array of applications for the increased signal gain provided by CubeSat-deployable, large aperture antennas.

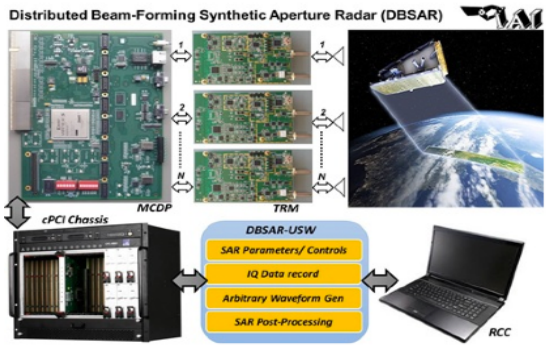
Already, one such application, an Earth Observation adaptation of NASA's iSAT CubeSat for Army Space and Missile Defense Command (SMDC), present a tangible opportunity.

Non-NASA Applications

SMDC's iSAT application actually anticipates an emerging military role with the goal of providing real time "over the horizon" imaging directly to warfighters in theater.

Intelligent Automation, Inc.

Innovation



Conventional SARs operate in a Stripmap mode. Wide unambiguous swath coverage and high azimuth resolution pose contradictory requirements on the design of SAR systems. A promising technique to overcome this limitation is Digital Beam-Forming (DBF) on receive, where the receiving antenna is split into multiple sub-apertures. This provides the capability of forming multiple beams via post-processing. DBF techniques applied to SAR systems can increase receiving antenna gain without a reduction of the imaged area while suppressing interference signals. A highly capable DBSAR instrument design would consist of wideband Transmitter- Receiver Module (TRM), precise multi-channel timing and synchronization and reconfigurable processing engine that can host the SAR processing, calibration and control routines. IAI's proposed approach is modular, scalable and meets the NASA goals of developing an innovative analog/digital hardware design for the implementation of distributed DBSAR architectures.

Applications

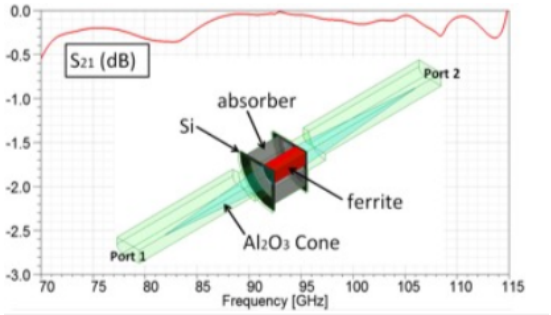
DBSAR be used for a wide range of remote sensing applications for NASA including:
- Reconfigurable radar systems for UAVs, manned aircrafts and spacecraft
- Tomographic Radar for Biomass and Ice-sheet imaging.
- Algorithm development platform for existing NASA radar platforms
- Objective 3: Develop transition plan for Phase-II design, system validation and commercialization

Non-NASA Applications

The most promising commercial applications of DBSAR, besides NASA applications are:
- Real-time digital processors
- Multi-channel arbitrary waveform generator/ recorder
- Direction direction-finding

Micro Harmonics Corporation

Innovation



Ferrite based isolators and circulators are highly useful for controlling standing waves and directing signal flow in millimeter-wave and terahertz systems. At frequencies above 75 GHz, there are relatively few vendors and the components are unsuitable due to high insertion loss in the isolators and narrow bandwidth in the circulators. There is ample evidence that these components can be substantially improved. Using modern electromagnetic simulation tools, ferrite components will be designed that exhibit significantly reduced loss and improved power handling and bandwidth making them useful for many of the systems now being developed for NASA. Ultimately, the goal is to develop a full line of ferrite components operating from 75 GHz to over 320 GHz with significantly improved performance over the current state-of-the-art. These components would find immediate use in broad range of commercial and scientific systems operating in the band from 75 GHz to over 3 THz.

Application

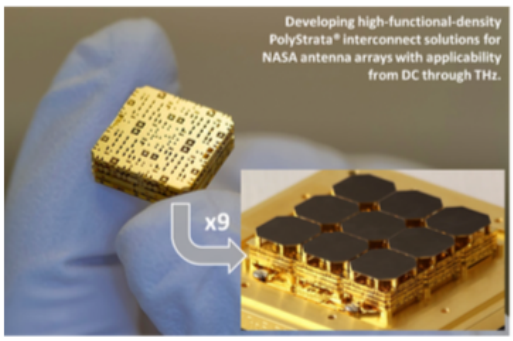
The proposed ferrite devices would find application in radars for measuring microphysical properties of clouds and upper atmospheric constituents, heterodyne receivers used in NASA's Submillimeter Missions such as Marvel, VESPER, MACO as well as earth observing satellites such as SIRICE. They are useful in a broad range of laboratory instrumentation as well as scientific instruments for plasma diagnostics (ITER), chemical spectroscopy, biomaterial analysis, and radio astronomy.

Non-NASA Applications

Ferrite devices are fundamental building blocks that find application in virtually any system working at millimeter-wave to terahertz frequencies. Example systems include compact range radar, imaging, covert communications, chemical and bio- agent detection, scientific and laboratory test equipment, biomedical, portal security scanners, high frequency data links and industrial process control.

Nuvotronics, LLC

Innovation



At the core of these innovations is the PolyStrata® additive microfabrication process, which has been tailored specifically for meeting modern day needs for highly integrated, low-loss interconnect technologies. Robust interconnects with broadband performance and high power

handling will enable high-yield antenna array assemblies with increased functional density. Proposed solutions will enable highly integrated, low loss feed networks that integrate microwave passives in a compact package to support desired capabilities.

Application

These interconnect solutions apply to future Earth science remote sensing missions including the Aerosols/Clouds/Ecosystems (ACE) mission and the Cloud and Precipitation Processes Mission (CaPPM) for vision beyond GPM; and the Snow and Cold Land Processes (SCLP) mission. This technology also has applications in planetary landing radars (Mars Science Laboratory mission). Additionally, the CubeSat platform can leverage the size, weight, and performance advantages of the PolyStrata technology.

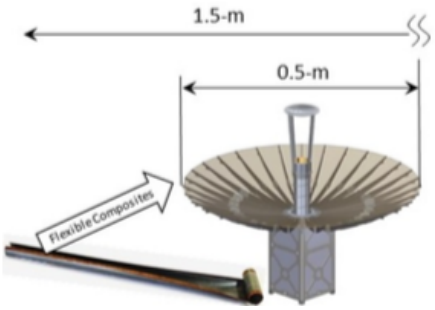
Non-NASA Applications

A wide variety of military and commercial antenna array applications, including: microwave and mmW active electronically scanned radar systems for rotorcraft landing in degraded visual environment (i.e. brown-out conditions); guided missile seekers; non-lethal active denial directive energy systems; unmanned aerial system collision avoidance; and high-bandwidth point-to-point datalink systems.

Tendeg LLC

Innovation

Develop a Ka-band deployable mesh antenna that can package within a 2U-3U CubeSat volume and deploy to diameters of 0.8-1.5m.



Application

The primary NASA target application for the proposed ROC-Rib deployable antenna technology is future NASA CubeSat and SmallSat spacecraft for which communications up/downlink or passive RF remote sensing measurement resolution is a major bottleneck in the system design. In particular, the proposed technology will enable very high bandwidth communications on the order of 10s of Mbps and/or very high-resolution radiometric remote sensing of atmospheric phenomenon.

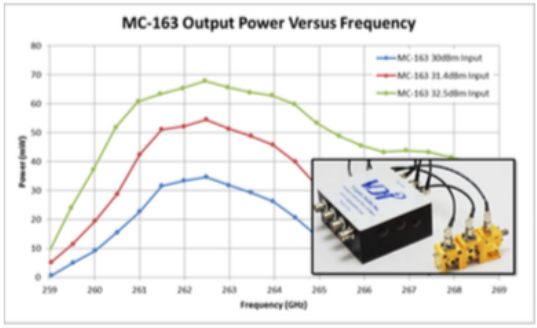
Non-NASA Applications

Beyond NASA applications, the proposed ROC-Rib deployable antenna technology could see use in other military and commercial applications where data up/downlink or passive RF sensing is a considerable need. Terrestrial-based applications might include portable communication networks that desire Ka-band operations and can benefit from lightweight, portable and deployable high-gain apertures.

Virginia Diodes, Inc.

Innovation

The performance of VDI's high power multipliers can be improved to exceed NASA's requirements through the further development and optimization of three innovative technologies:



1) Optimization of the use of diamond heat spreaders to achieve improved thermal management and therefore lower diode operating temperatures.
2) Development of a practical method of four-way, in-phase power combining within the multiplier housing.
3) The use of active biasing technology to ensure that the diodes are automatically at their optimal bias point even as the source frequency is rapidly tuned across the operating band.

Application

Heterodyne receivers have been demonstrated to frequencies as high a 4.7THz. These are generally used for radio astronomy from airborne or space platforms. The development of higher power sources in the frequency range around 300GHz is a critical step that is required to enable the development of array receivers for astronomy in the terahertz band.

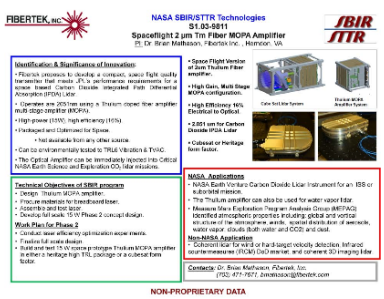
Non-NASA Applications

Non-NASA applications include the NMR-DNP and EPR measurements for chemistry and high power sources for reflectometry measurements for plasma diagnostic systems for nuclear fusion experiments. Higher power solid-state sources can be used in imaging systems; for portal security, collision avoidance radars, fire-fighting, and industrial process control and monitoring.

Sensor and Detector Technology for Visible, Far IR & Submillimeter

Fibertek, Inc.

Innovation



Develop a compact, space flight quality transmitter that meets JPL's performance requirements for a space based Carbon Dioxide Integrated Path Differential Absorption (IPDA) Lidar.

-Operates are 2051nm using a Thulium doped fiber amplifier

multi-stage amplifier (MOPA).

-High-power (15W), high efficiency (16%).

-Packaged and Optimized for Space and not available from any other source.

-Can be environmentally tested to TRL6 Vibration & TVAC.

-The Optical Amplifier can be immediately injected into NASA Earth Science and Exploration CO2 lidar missions.

Application

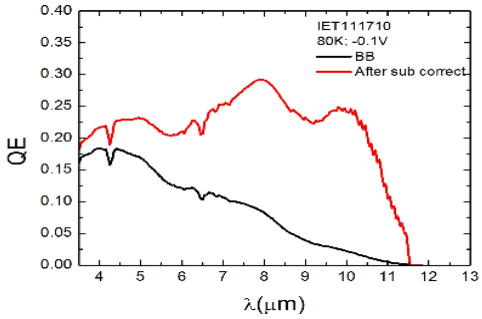
NASA Earth Venture Carbon Dioxide Lidar Instrument for an ISS or suborbital mission. The Thulium amplifier can also be used for water vapor lidar. Measure Mars Exploration Program Analysis Group (MEPAG) identified atmospheric properties including: global and vertical structure of the atmosphere, winds, spatial distribution of aerosols, water vapor, clouds (both water and CO2) and dust.

Non-NASA Applications

Coherent lidar for wind or hard-target velocity detection, Infrared countermeasures (IRCM), and coherent 3D imaging lidar.

IntelliEPI IR, Inc.

Innovation



Develop high performance (low dark current, high quantum efficiency, and low NEdT) infrared epitaxy materials based on Type II Strained Layer Superlattice (SLS) for large format space- based sensor applications. The epi materials will be grown with Sb-capable multi-wafer production Molecular Beam Epitaxy (MBE) reactor at IntelliEPI IR. The initial goal includes achieving QE of at least 40% with LWIR spectral wavelength band near 12 um. The SLS detector design will be developed in consultation with the infrared detector group at JPL to ensure that this effort addresses NASA needs.

Application

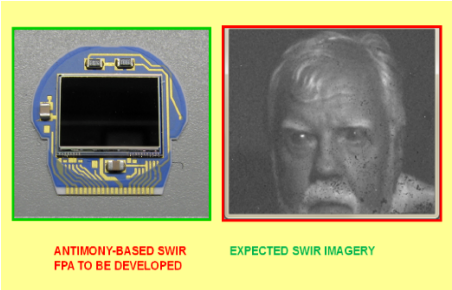
Type II SLS technology can serve as a platform for the next generation of space- based high performance and large format infrared FPAs. This will be a materials evolution of the on going SLS technology being developed at JPL. This SLS technology offers a unified platform for high-performance 5-14 um detection wavelengths. Substrate size scaling will support large format infrared imaging NASA needs with high sensitivity and high operating temperature sensors for space-based applications.

Non-NASA Applications

Improved Type II SLS technology offer thermal imagers at higher operating temperature, uniformity, and sensitivity from mid wave to long wavelength infrared based on scalable GaSb substrates. This opens the door for more military vehicles/platforms to be outfitted with these high performance cameras. Commercially, environmental or gas sensing can benefit from competitive cost scaling.

QmagiQ

Innovation



1) Shortwave infrared focal plane array (SWIR FPA) with 2.5 micron cutoff
2) Spectral response extended into visible (500 nm) by removal of detector substrate
3) Using novel antimony-based InAs/GaSb/AlSb sensor material system
4) Bandgap-engineered and specially processed to minimize dark current
5) Quantum efficiency and dark current expected to be comparable to mercury cadmium telluride (MCT) 6) Cost much lower than MCT due to leverage of commercial growth and process equipment

Application

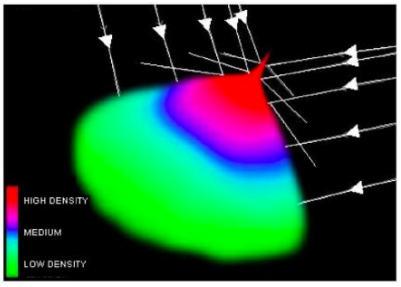
1) Space- and ground-based astronomy and astrophysics
2) NASA's earth-observing missions in the shortwave-infrared and visible spectral bands
3) Chemical/spectral mapping of forests, vegetation and crops
4) Atmospheric mapping
5) Pollution monitoring
6) Temperature mapping of oceans and landmasses

Non-NASA Applications

1) Hyperspectral imaging systems for inspection of agricultural produce and pharmaceutical drugs
2) FTIR imaging microscopy
3) Gas imaging (e.g. for the petrochemical industry)
4) Security and surveillance (day and night)
5) Medical imaging

In Situ Sensors & Sensor Systems for Lunar and Planetary Science

Connecticut Analytical Corporation



Innovation

A large percentage of analytical analysis performed by both

manned and unmanned NASA missions involves the use of a mass spectrometer. However, probably the most significant hurdle yet to overcome is how one can create a cost effective, small, and low power vacuum system for the MS. Over the past 30+ years, no significant advance in vacuum pump concepts save for the turbo-molecular pump, have been realized.

Application

Any analytical instruments that require high vacuum such as mass spectrometers used on the ISS or future missions to planets such as Mars. The proposed pump concept may allow for smaller, lighter weight in-situ sensor suites for future robotic missions. The preferred objective for the electrospray pump is with regards to MEMS based mass analyzers. Such a MEMS based ion trap mass spectrometer was recently demonstrated by Sandia National Labs.

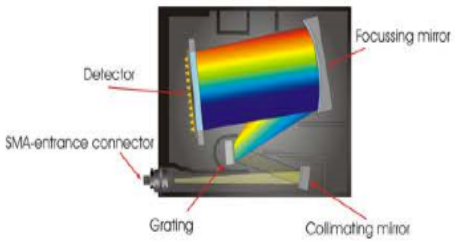
Non-NASA Applications

Non-NASA: High Vacuum Deposition systems, commercial Mass spectrometers, and all analytical instruments that require high vacuum for operation would benefit from the proposed electrospray high vacuum pump concept. In particular, the Dept of Homeland Security is seeking new hand-held instruments with greater chemical sensitivity and specificity, which would benefit from an electrospray MEMS pump.

Energy Research Company

Innovation

Energy Research Company (ERCo), in collaboration with CoVar Applied Technologies, proposes the development of a spectrometer enhancement technology that will increase the amount of light measured by spectrometers. The technology can reduce the size and weight of spectrometer systems, another important goal for space instruments, while maintaining light levels. This performance gain is achieved through the use of computational imaging technology.



Applications of the spectrometers include sensing modalities such as Laser Induced Breakdown Spectroscopy (LIBS), Raman spectroscopy, and infrared spectroscopy. The market advantages of the concept are its higher performance than current compact spectrometers, and lower cost, lighter weight, and smaller size as compared to high performance spectrometer systems.

Application

NASA has multiple programs that would benefit from the technology including the Discovery Program, New Frontiers, Mars 2020, and the Europa-Jupiter System Mission. NASA's roadmap for technology development in this area also calls for compact spectrometers for mineralogy. These devices would also benefit from the proposed technology.

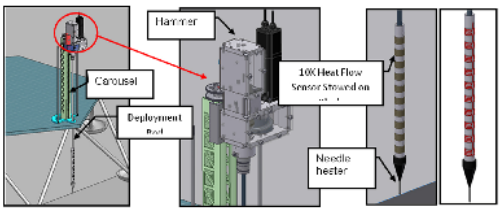
Non-NASA Applications

Users of spectrometers include academic, government, and industrial laboratories and research organizations. Manufacturers of process control equipment and environmental sensors, among others, incorporate spectrometers into their products. Improvements in spectrometer technology can therefore have wide ranging beneficial effects in advancing science, engineering, and manufacturing.

Honeybee Robotics, Ltd.

Innovation

Lunar heat flow properties are very important information for studying the radiogenic isotopes, the thermal evolution and differentiation history, and the mechanical properties of the interior. In order to obtain the best measurements, the sensors must be extended to a depth of at least 3 m, i.e. beyond the depth of significant thermal cycles.



Application

In addition to measuring heat flow on the Moon, the probe can be deployed on the future Discovery- and New Frontier-class robotic missions to Mars, and other planetary bodies. The instrument may be used by astronauts on Sortie human lunar missions. The percussive penetrometer can also be used to deploy other sensors, such as Neutron and Gamma spectrometer and Electrical Properties probe. The tool could also provide geotechnical measurements of lunar subsurface to a depth of 3 m.

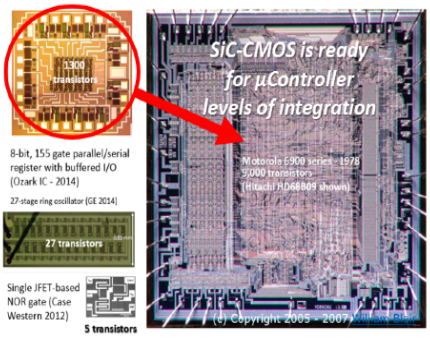
Non-NASA Applications

Non-NASA applications include measuring of heat flow in areas on earth, where optimal thermal isolation of heaters/temperature sensors is of paramount importance. These for example include areas with hydrocarbon potential. Therefore exploration companies, such as Shell or Chevron, would in particular be interested in this technology.

Ozark Integrated Circuits, Inc.

Innovation

Devices that can operate at temperatures of up to 500 C are desired. Ozark IC and its partner, the University of Arkansas, have created the world's largest known library of CMOS silicon- carbide (SiC) analog and mixed-signal circuits, intellectual property (IP) and packages that can operate at very high temperatures. The key next component is a general-purpose SiC microcontroller to provide real-time programmability for these SiC support circuits.



This proposal will use the extensive Ozark IC SiC library to develop a self-contained general-purpose SiC microcontroller. When combined with data converters, gate drivers and other

analog/mixed-signal circuitry, this microcontroller could serve in any number of high-temperature sample acquirement and analysis instruments.

Application

NASA has demonstrated a resolve for a flagship mission in the coming years to revisit Venus, and land instruments on the surface. Venus has a corrosive, high- pressure (~100 bar), high-temperature (up to 500 Celcius) environment.

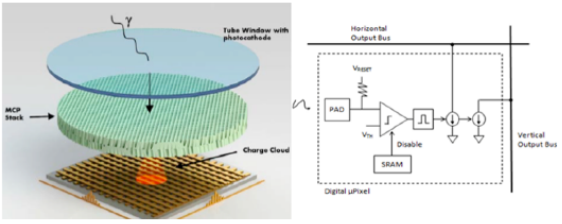
The SiC microcontroller represents a major step in creating a general-purpose SiC- based chipset that will support a majority of functions required by a Venus lander.

Non-NASA Applications

Other non-NASA applications include any market that needs a programmable microcontroller that will operate over an extremely wide temperature range. These markets include, but are not limited to, Military Aerospace, Military/Non-Military Space Applications, Commercial Aviation and Oil Exploration.

Voxtel, Inc.

Innovation



In situ planetary instruments face challenges that greatly exceed even the challenges of developing in-space Earth-orbiting instrumen ts. Because of restricted payload masses for these ambitious missions, planetary in situ instruments must be very small (a few kg, at most), consume low power (20W or less), take up low volume (a few liters, at most), and be highly automated from instrument turn-on to data transmission. To address this need a compact improvement on time-resolved streak-tube and intensified photodiode (IPD) technology will be developed which is better at achieving the sensitivity, resolution, and count rates. The proposed hybrid intensified solid-state pixelated anode detector (ISPAD) senses and time-stamps MCP- multiplied electron clouds at picosecond time scales, allowing photon detection with subpixel spatial resolution, at rates ranging from a few counts per second to billions of counts per second.

Application

Applications include: Raman spectroscopy, in situ measurements, LIBS, Freespace Optical Communication, charge particle detectors, Photon Counting, Laser Radar (LADAR), LIDAR, and time-resolved imaging applications.

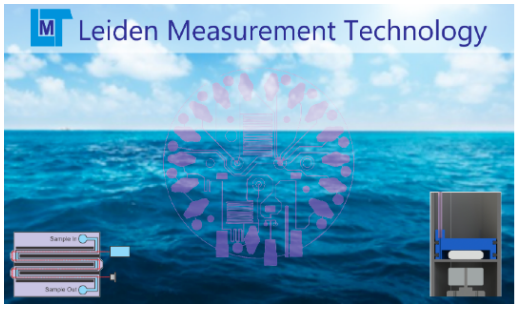
Non-NASA Applications

Applications include: Automotive collision avoidance, LIDAR and LADAR instruments, night vision imaging, time-resolved spectroscopy, and fluorescent decay measurements.

Surface & Sub-surface Measurement Systems

Leiden Measurement Technology, LLC

Innovation



Two novel microfluidic innovations: (1) a novel folded long-path (250-mm) absorption cell utilizing lock-in amplified detection to enable high colorimetric detection sensitivity; (2) a novel system for mixing chemical solutions dry chemical components to enable their in-situ preparation, enabling long-duration deployments where pre-mixed consumables would have otherwise degraded. These two innovations will enable the construction of the In-situ Nitrate/Nitrite Analyzer (INNA), a deployable microfluidic system for the continuous, autonomous, long- duration analysis of nitrate and nitrite in natural waters that will feature unprecedented sensitivity and autonomous deployment durations for this class of robust microfluidic system. INNA will be able to detect nitrate and nitrite down to single-digit nano-molar levels, making the instrument suitable for monitoring nutrients even in the oligotrophic open ocean where levels of these compounds can be below 10 nM.

Application

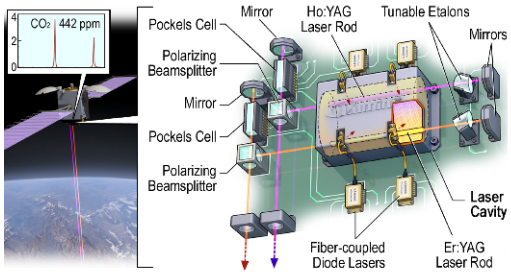
INNA is directly relevant to NASA's Earth Science studies for understanding oceanic ecosystems and the oceanic nitrogen cycle. An array of INNA instruments could potentially be used to support the Aerosol/Cloud/Ecosystems mission. The technology developed for INNA could also be used to augment NASA's existing microfluidic platforms such as PISCES (Peter Willis, JPL). It could also be used in testing exploration strategies for watery and icy worlds (e.g., Europa, Mars polar ice caps).

Non-NASA Applications

There is a growing need for low-power, highly-sensitive, autonomous instruments that can operate for months to years between servicing that can detect inorganic ions such as nitrate and nitrite in the ocean. Large-scale ocean observatories are being built across world and INNA would be a highly-competitive instrument as it would beat competition on sensitivity and/or time-between-servicing.

Luminit, LLC

Innovation



NASA has proposed such projects as Global Precipitation Measurement, Geostationary Coastal and Air Pollution Events, and Active Sensing of CO2 Emissions over Nights, Days, and Seasons. In support of these programs, and in particular ASCENDS, Luminit, LLC, proposes to develop the innovative

Multiwavelength Greenhouse Gas Lidar (MUGGLE). The MUGGLE is a high-resolution spectroscopic measurement system that can detect and measure CO, CO2, CH4, and H2O (vapor) with great accuracy and speed. The MUGGLE will be fully automated, using only eye-safe laser wavelengths and powers, with tunability and real-time calibration. The MUGGLE will achieve laser linewidth <50 MHz for the best resolution, and significantly improves on existing greenhouse gas measurement technology.

Application

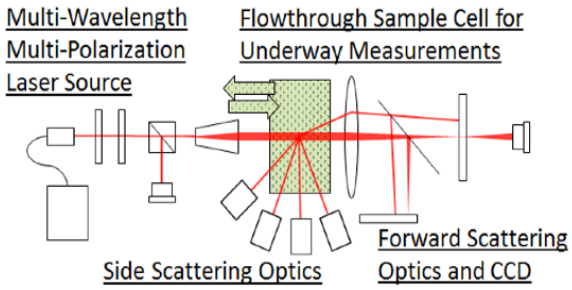
Systems like ASCENDS, OCO-2, GPM, GEO-CAPE, etc. will immediately benefit from MUGGLE technology. Other fielded projects will follow, e.g., ocean biology and biogeochemistry. The NASA Glenn Chemical Species Gas Sensors Team is developing gas sensing technology for aeronautic and space applications which can be addressed by the MUGGLE, especially since its laser rods can be changed to other materials in order to reach different spectral regions. These are ideal applications of MUGGLE technology.

Non-NASA Applications

Gas detection sensors are becoming more and more important in the commercial world. Gases such as CO, CO2, and especially CH4 need to be measured with accuracy and speed, which is where the MUGGLE demonstrates its greatest improvement over state of the art. The first commercial application of the MUGGLE is likely to be a CH4 sensor for use finding industrial and pipe leaks.

Sequoia Scientific, Inc.

Innovation



Particle size distribution (PSD) is a fundamental environmental measurement, with diverse biogeochemical applications including carbon cycle science, ecosystem and fisheries modeling, and harmful algal bloom (HAB) detection/prediction. There is optimism that estimates of PSD will be available from ocean color measurements (such as NASA's upcoming PACE mission), and will be able to help constrain global-scale ecosystem/carbon models and estimates of primary production. However, natural PSD variability is not well understood due to the challenges of routine measurement, and there exists little field data over large space and time scales. We propose to bridge this gap by investigating an instrument for ship-based flow-through application that uses laser scattering from multiple wavelengths and polarizations for estimation of the PSD across a wide range of particle sizes from submicron to >200 micron, covering a range from the smallest oceanic pico-plankton to larger meso-plankton.

Application

Given the current push within NASA programs in preparation for launch of the PACE ocean color mission, development of this system is very timely to aid in algorithm development and enhance Carbon Cycle and Ecosystems research.

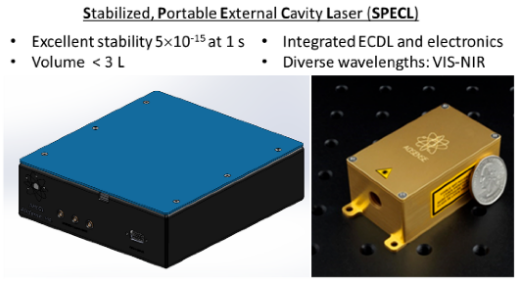
Non-NASA Applications

Agency-funded (including NSF, EPA, NOAA) researchers routinely use turbidity, pigment analysis, and cell counts for water quality monitoring and science applications. The ability to make measurements of PSD at higher space-time resolution would be significant. One potential application with major societal relevance is routine monitoring of changes in PSD in detecting harmful algal blooms.

Atomic Interferometry

AOSense, Inc.

Innovation



Several space and terrestrial applications could benefit from portable, low size, weight, and power (SWaP) clocks with fractional instabilities <1e-14 at 1 s and <1e-16 at 1 to several days. A core technology for these clocks is a frequency-stabilized laser, which serves as the local oscillator. Commercially-available stabilized laser systems can meet the stability specifications, but in ~30 L form factors and only for certain wavelengths (e.g. telecom lasers). For deployable atom-based clocks and inertial sensors, the target size is often sub-liter or smaller for the entire system. Furthermore, optical clock transitions typically occur at wavelengths inaccessible by solid state lasers.

Application

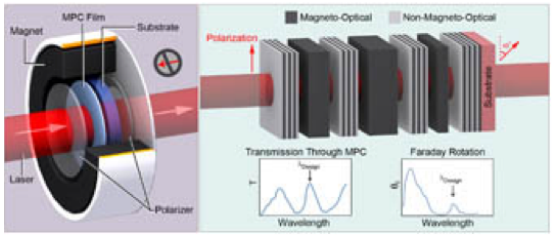
Optical atomic clocks; Gravitational wave detection with single baseline interferometers; deep space navigation; real-time autonomous navigation; one-way, deep-space data links; LIDAR.

Non-NASA Applications

Secure data routing; communication systems insensitive to jamming; high resolution coherent radar; extended mission duration in GPS-denied environments; improved system integrity and a reduction of clock corrections and maintenance for the GPS constellation; Quantum computing.

Physical Optics Corporation

Innovation



To address NASA's need for miniature optical isolators in atom interferometry applications, Physical Optics Corporation (POC) proposes to develop a miniature optical isolator based on magnetic photonic crystals optimized at visible and NIR wavelengths. The proposed optical isolator design is based on enhanced magneto-optical effects in photonic crystals. With the proper lattice parameter and magnetic material, high optical transmission and large Faraday rotation can be achieved simultaneously at a target wavelength. A proposed

device, occupying < 0.1 cc, is expected to achieve high optical transmittance (loss <2 dB) and excellent optical isolation (extinction >40 dB); therefore, it is suitable for applications in various compact atom interferometers. In Phase I, POC will demonstrate the feasibility of the technology in the visible range and provide a Phase II prototype design. In Phase II, the technology will be further optimized and tested in operational environments.

Application

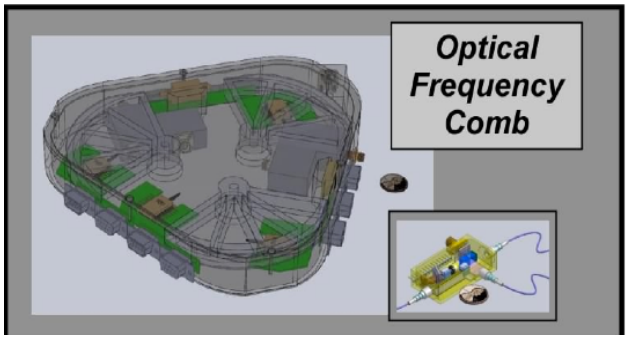
The primary NASA applications of the proposed MOI system are in metrology, magnetometry, and inertial navigation. NASA applications require miniaturization of all system components. Frequency stabilized lasers are currently used in atomic clocks. Next-generation magnetometers and inertial navigation sensors also need optical isolation. In any NASA application that requires frequency stabilized lasers, MOI devices can replace bulky optical isolators to reduce the volume by a factor of >100.

Non-NASA Applications

Metrology and inertial navigation are important in military and civilian applications. Cold-atom based technologies require compact optical systems, and miniature optical isolators are one of the key components. These optical isolators also have significant commercial applications in diverse fields, such as optical telecommunication, magneto-optic imaging, and gas sensing.

Vescent Photonics, Inc.

Innovation



Design, fabricate, and test a polarization maintaining fiber frequency comb useful for frequency stability transfer from the optical domain to the RF domain. Vescent will design and fabricate a fiber-coupled semiconductor saturable absorbing mirror with actuator to control the comb repetition rate. Follow on research will develop compact diode lasers that will conveniently phase lock to a comb tooth for the purpose of stabilizing a comb tooth or the laser diode.

Application

Position, navigation, and timing applications (PNT), exoplanet exploration, precision LADAR, sensitive tests of General Relativity, and precision spectroscopy for Earth and planetary science. For example, the NASA SCaN office desires precise free-space timing networks for navigation, and to improve data transmission rates.

Non-NASA Applications

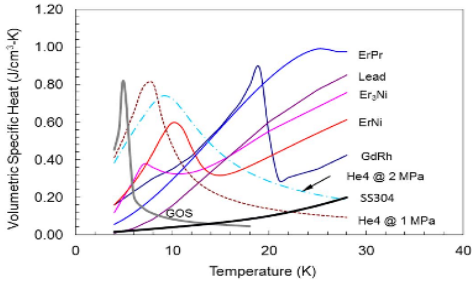
Applications include: an absolute frequency ruler that covers the visible to near-IR range that can be used for laser stabilization and absolute referencing, and precise distance metrology and mapping using LIDAR. Comb-based spectroscopy including cavity-enhanced spectroscopy provides a tremendous spectral coverage with accurate wavelength position in a relatively compact optical system.

Cryogenic Systems for Sensors & Detectors

Creare, LLC

Innovation

Highly efficient, reliable, lightweight cryocooler for science instruments in planetary missions. Innovative regenerator fabrication process to enhance regenerator thermal efficiency and thus overall cooler performance: 1) Unique, reliable process to enhance heat capacity of regenerator at low temperature; 2) Tunable regenerator flow passage geometry for optimal thermal and fluid performance



Innovative Fabrication Approach to Use Rare Earth Material to Enhance Regenerator Thermal Performance

Benefits: Low cooling temperature; Low-cost, reliable cryocooler; Lower power input and lighter cryocooler

Application

Cryocooling systems for detectors, sensors in planetary science missions, remote science sensing missions, high altitude balloons.

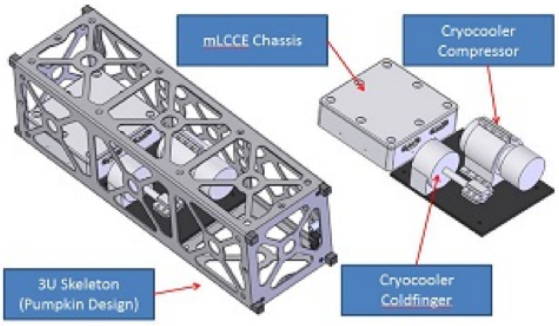
Non-NASA Applications

Cryocooling systems for space-based surveillance. Highly efficient cryocoolers providing cooling below 30K, a temperature range that is currently unachievable with commercial Stirling cryocoolers.

Iris Technology Corporation

Innovation

The CubeSat Cryocooler System (CCS) provides an enabling technology for detectors and sensors requiring cryogenic cooling aboard CubeSat platforms. The system is comprised of a novel high efficiency, low power, two-stage coldhead pulse tube cryocooler and a miniature low-cost cryocooler electronics board to drive it. The cryocooler would enable a cooling capacity on the order of 0.2W at 50K-80K with less than 5W power input. The miniature electronics will incorporate high reliability COTS components were applicable, and have demonstrated a modular "plug-and- play" capability, resulting in a significant cost and time savings.



Application

The CCS is targeted at NASA applications requiring miniature spacecraft or unmanned aerial vehicles for science gathering missions. More specifically, the CCS can support the Science

Mission Directorate by enabling research in the areas of Astrophysics, Earth Science, Heliophysics and Planetary Science. The CCS enables any instrumentation requiring cryogenic cooling.

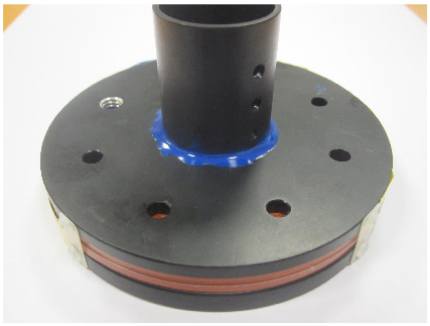
Non-NASA Applications

The growing UAV and CubeSat markets are ideal non-NASA CCS applications. Lockheed Martin has expressed interest in mini cryocooler systems to support future UAV missions. Commercial CubeSats are being used for Earth-imaging and geostationary tracking, which are great applications for the CCS. Small satellites satisfy a growing range of data gathering missions that require high-accuracy sensors.

Superconducting Systems, Inc.

Innovation

There are currently cryocoolers that can achieve 3.5-4 K. But considering the power ratios, weight, and expected lifetime, operating ADRs with heat sink temperature of less 30-40 K can be advantageous. In fact if a multistage ADR system could reject its heat at about 30K or above, the approach of passive radiative cooling can come into serious consideration thereby mechanical cryocoolers can be totally removed from the overall cooling system. This can be a significant breakthrough in wider application of ADRs & other superconducting magnets in space applications.



This proposal executes a development of a road map and delivers a fully functioning 3T HTS ADR magnet operating at 30 K.

Application

In addition to ADR systems, other NASA applications include efficient motors and generators, MHD propulsion, high precision sensors and actuators, electromagnetic launch, and magnetic resonance imaging in space.

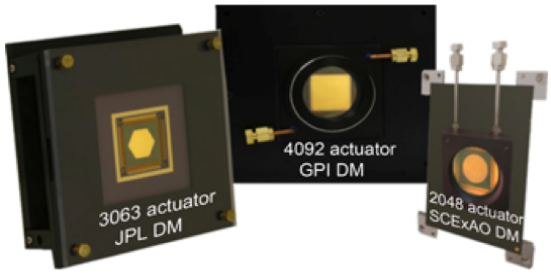
Non-NASA Applications

Applications include efficient motors and generators, MHD propulsion, high precision sensors and actuators, electromagnetic launch, and magnetic resonance imaging in space. Larger efficient motors and generators may have applications in the power generation, and transmission industries. Applications in vehicle and appliance industries can be envisioned as this technology advances.

Proximity Glare Suppression for Astronomical Coronagraphy

Boston Micromachines Corporation

Innovation



Space-based coronagraphs comprise one NASA-led approach to collecting spectral data from such exoplanets. These instruments demand unprecedented optical contrast, which in turn requires precise compensation of wavefront errors. Deformable mirrors (DMs) made using BMC's silicon fabrication technology have proven uniquely enabling for this application due to their capacity to assume shapes with nanometer-scale precision and without hysteresis in arrays comprised of thousands of actuators. NASA's Solicitation topic S2.01 Proximity Glare Suppression for Astronomical Coronography calls specifically for small stroke, high precision, DMs scalable to 10,000 or more actuators. In this project, BMC will conduct processing and design research aimed at improving yield, performance, and reliability of high actuator-count deformable mirrors (DMs) to achieve that goal.

Application

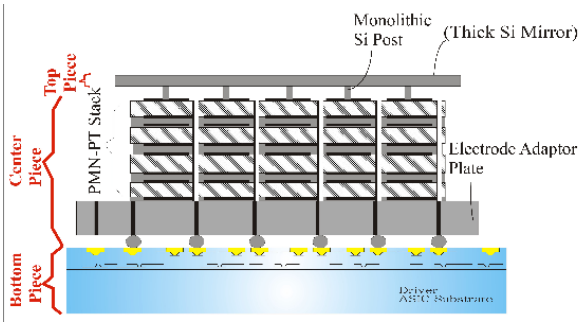
NASA applications in need of deformable mirrors with improved yield, performance and reliability over the current state-of-the-art are space-based astronomical imaging systems, such as direct imaging of exoplanets with coronagraphic telescopes. The development of this deformable mirror technology will ultimately increase the capabilities of NASA missions, directly coinciding with the 2011 NASA Strategic Plan.

Non-NASA Applications

Many applications outside of astronomy require MEMS deformable mirrors. These include microscopy, optical communication, retinal imaging, laser pulse shaping, and space surveillance. The proposed program will benefit each of these applications by providing improved manufacturability due to increased fabrication yields of the MEMS devices, enhanced operational performance, and better reliability.

Microscale, Inc.

Innovation



Micro fabrication manufacturing of piezoelectric stack actuators, deformable mirror in integration with driver ASIC Significances : 1 order of magnitude improvement on electro-mechanical performances over traditional state of the art piezoelectric DMs; 1 order of magnitude reduction of DM cost ; 1~2 order of magnitude reduction of driver electronics power dissipation; and 2 orders of magnitude reduction on the DM system's form factor (size/weight).

Application

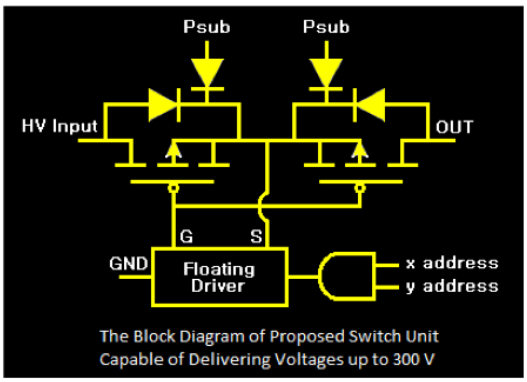
Visible Nulling Coronagraph (VNC), single aperture far-infrared observatory (SAFIR), Extrasolar Planetary Imaging Coronagraph (EPIC), Terrestrial Planet Finder (TPF), Submillimeter Probe of the Evolutionary Cosmic Structure (SPECS), the Stellar Imager (SI) and the Earth Atmospheric Solar occultation Imager (EASI).

Non-NASA Applications

Commercial: retinal imaging and laser surgery instrumentations, ophthalmology and other microscope applications, optical communications, telescopes, direct retinal display, and projection display.

Sunlite Science & Technology, Inc.

Innovation



The Block Diagram of Proposed Switch Unit Capable of Delivering Voltages up to 300 V

One preferred approach to directly image an exoplanet is to build a space- based telescope instrumented with advanced internal coronagraphs, where deformable mirrors (DMs) with high actuator counts are essential for achieving very high contrast detection. When actuator quantities are in thousands, the electrical driver poses a fascinating challenge for space- based applications, where power and mass are limited, and reliability is extremely important for the mission life-time in space. The proposed 64x64 ASIC driver can deliver voltages up to 300 V, which will significantly reduce a space based AO system by at least one order with respect to power, size, cable number, weight, and cost. More importantly, the concerning of the reliability of electrical connections will be cleared up. Furthermore, radiation resistance will be emphasized during ASIC design.

Application

The proposed ASIC driver is specifically designed to drive a stacked DM that NASA has been qualified in ground. It could provide a reliable, low power, monolithic DM driver that can be used by an exoplanet-imaging coronagraph. Thus, it could be found valuable in applications on those missions, such as WFIRST and ATLAST, where coronagraphic instruments are required.

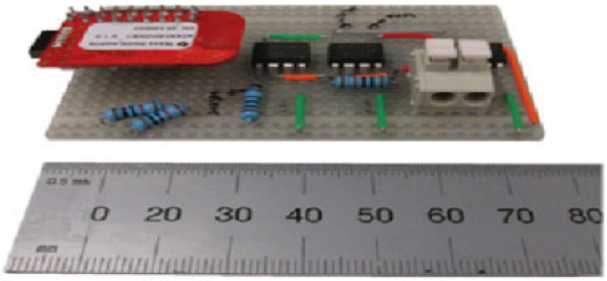
Non-NASA Applications

With a vertically integrated ASIC driver, the yield and reliability of a DM will be greatly improved. DMs with tens of thousands of actuators will become possible at affordable prices, which could attract more AO applications such as retinal imaging, fidelity microscopy imaging and laser drilling.

Precision Deployable Optical Structures & Metrology

Extreme Diagnostics, Inc.

Innovation



This project creates a Cubesat-based on-orbit Validation System (CVS) that provides performance data for Macro Fiber Composite (MFC) piezocomposite actuators operating in space and matures this precision deployable technology through tests in Low Earth Orbit (LEO). The piezocomposites needed for active structure control have flown, but only in a shielded enclosure for a short duration. These materials need to operate continuously with minimal thermal protection to enable large deployable precision structures like 10-30 m class space telescope observatories. Data is needed on the viability of piezocomposites for space. These materials also enable active structural health monitoring (SHM) techniques that assess structural integrity during normal space operations.

Application

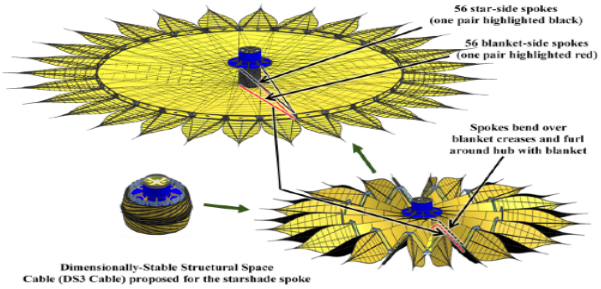
Piezocomposite material applications include active control of composite reflectors, large sunshields, external occulters, large solar arrays for solar electric propulsion and other active structures. Maintaining the shape of large, high-precision reflectors will be quite difficult; active reflectors that adjust their shape in situ will be cheaper and lighter. Additionally, an active, mission-capable SHM system has applications like crew safety, deep-space missions, and vehicle mass reduction.

Non-NASA Applications

Commercial space companies need SHM to reduce time to launch and improve safety, flight recertification, vehicle operation models, and service life predictions. Other applications include Homeland Security structural analysis to mitigate threats (preparedness) and assess damage (response), smart structures, and SHM of civil structures like wind energy turbines (alternative and renewable energy).

ROCCOR, LLC

Innovation



Dimensionally-Stable Structural Space Cable (DS3 Cable) consisting of advanced fibers that enable linear and consistent behavior at very low operational tensions as well as a near-zero coefficient of thermal expansion (CTE). This work will also address feasibility concerns with manufacturing consistency and package-ability by fabricating a large quantity of test articles for evaluation at NASA-JPL. Although high performance carbon fiber cable has been used for space applications in the past, there are no commercially available cable products with the specifications necessary for this starshade application.

Application

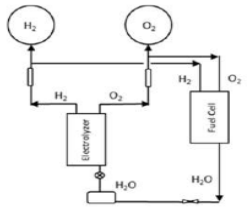
The development of Dimensionally-Stable Structural Space Cable has numerous applications to both current and future NASA development efforts. Most notably, this component is of critical importance for a starshade (external occulter) conceptual development effort currently underway at JPL. Other applications related to large deployable truss structures requiring tight packaging constraints, low response to thermal gradients and linear precision at low operational tensions.

Non-NASA Applications

High precision and thermally stable wire is being actively sought out to support development of high gain, deployable mesh antennas. Other terrestrial applications to support precision structures and optical surfaces are of interest as well.

Terrestrial & Planetary Balloons

ElectroChem, Inc.



High Energy Density Storage with non-flow-through fuel cell and static feed electrolyzer

Innovation

A RFCs (Regen fuel cell system) is proposed for storing power at higher energy densities. It would store energy from solar panels for providing power during 12 hours or more of darkness for long duration missions of Terrestrial and Planetary Balloons. The Regen system will include, a non- flow through IFF PEM fuel cell with a static feed PEM electrolyzer.

The significance of the innovations is that the RFC will be highly efficient - no pump and reactant circulation is required. Highly reliable - passive operation with minimum moving parts higher safety - eliminates reactant gas circulation

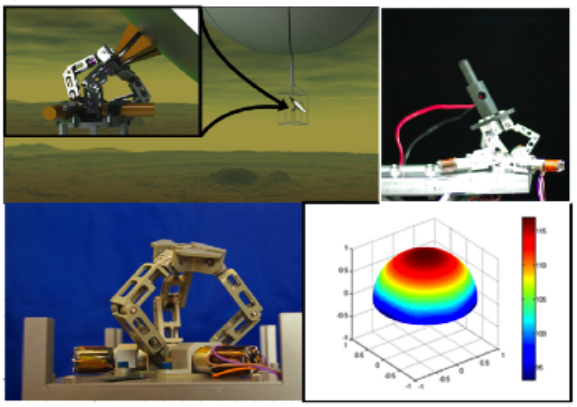
Application

Along with Terrestrial and Planetary Balloons missions, the technology can be used for the International Space Station (ISS), ECLSS, and ISRU systems, and for on- board power for various launch vehicles to surface electrical energy storage.

Non-NASA Applications

Applications include backup, remote, and residential off-grid electrical power. Specific market would be the telecommunications, electric power, business computer network. This fuel cell is air-independent which supports the unmanned aerial vehicles (UAV) and unmanned underwater vehicles (UUV).

Tethers Unlimited, Inc.



Innovation

The VORTEX Gimbal is a state-of-the-art mechanism that provides hemispherical pointing and constant slew and rotate without the need for costly and failure prone slip rings. The mechanism has already been flight qualified for nanosatellite missions. The design refinements proposed would result in a mechanism capable of providing this superior performance on Venus or Titan via buoyant vehicles. Components based on proven gimbal mechanism technology. Removes necessity for slip rings that are costly and prone to failure. Significantly less mass, volume and nominal power consumption than current gimbal technology. Introduces a third degree of freedom on top of hemispherical pointing to reduce stowed volume. Multiple actuation and encoding schemes provides the potential for extremely high resolution pointing.

Application

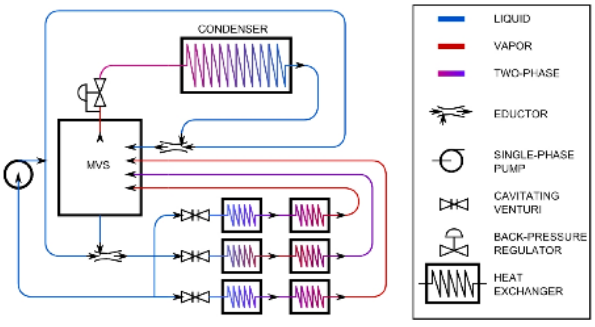
The primary application for the VORTEX Gimbal will be on Aerobot-based exploration missions on Venus and other planetary bodies, where it will provide a reliable, lightweight, autonomous mechanism for pointing high gain antennas used in telecommunications. The VORTEX Gimbal will not be limited to this use case, however. This mechanism will be useful for any mission with instruments that require precision pointing and data throughput, such as sensors, imagers, solar arrays, and thrusters.

Non-NASA Applications

The VORTEX Gimbal system can enable precision pointing in numerous terrestrial applications. The mechanism will be designed for the caustic environments on Venus and Titan and will be suitable for many other harsh environments on Earth. Potential applications include high-altitude balloon systems for broadband communications and balloon-launched astronomy and IMINT systems.

Thermal Control Systems

Advanced Cooling Technologies, Inc.



Innovation

Development of an active Two-phase Thermal Management System (TPTMS) that relies on a liquid pump to drive two-phase flow through multiple heat loads distributed in parallel and in series while providing phase management using the momentum of the working fluid. The use of a liquid pump to drive the system allows the working fluid to overcome large pressure drops with low power consumption. This feature provides the ability to transfer

waste heat over large distances. Additionally, flow can be driven through multiple heat exchangers or cold plates to either collect or release thermal energy. Arranged properly, this feature allows for heat load sharing. Added to these benefits are those intrinsic to two-phase heat transfer: near-isothermal operation, a two order of magnitude increase in the heat transferred per unit mass and the ability to handle high heat fluxes.

Application

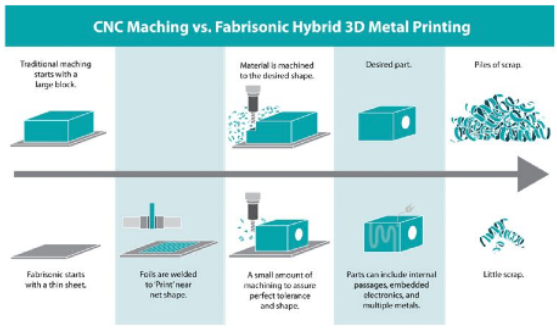
The TPTMS proposed here will provide a two-phase thermal management solution for spacecraft that is versatile with respect to system requirements and allows for efficient use of available mass, volume, and power budgets. Applications for this thermal management system would include spacecraft with thermal demands beyond the capabilities of capillary systems and those interested in low-cost alternatives to conventional thermal management systems.

Non-NASA Applications - Commercial satellite and spacecraft market. Depending on the phase separation performance of the MVS integrated with the TPTMS, there are possible military and commercial aircraft applications.

Sheridan Solutions, LLC

Innovation

This program will demonstrate the use of Ultrasonic Additive Manufacturing (UAM) to 3D print aluminum structural panels with integrated thermal management passages to be employed as components of advanced small spacecraft that have very small masses and temperatures highly sensitive to variations in the component power output and spacecraft environmental temperature.



Structures include pumped integrated heat exchangers for fluid loops, integrated heat pipes, and integrated wick systems. By combining two functions (structure/thermal) it will be shown that a lighter weight, higher performance solution can be built in a shorter time period.

The project team will demonstrate technical feasibility and will use UAM to 3D print an aluminum structure capable of carrying structural loads with integrated thermal management passages as may be used in a pumped integrated heat exchanger in a follow on effort.

Application

Typical initial UAM applications would include components of advanced small spacecraft that have very small masses with their temperatures highly sensitive to variations in the component power output and spacecraft environmental temperature. In both applications, UAM addresses competing system requirements for managing primary load paths and integrating thermal management into the structure.

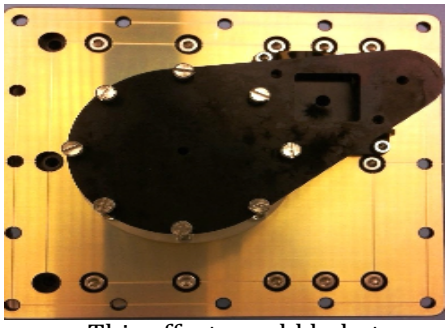
Non-NASA Applications

The initial application of high performance UAM-enabled thermal management devices will likely be in NASA, defense and commercial space structure programs, in that order. This estimate recognizes the high performance technology leading nature of the organizations and their missions. The project team already services aerospace customers.

Planetary Entry, Descent & Landing, and Small Body Proximity Operation Technology

Advanced Scientific Concepts, Inc

Innovation



Fabrication processing improvements have become available that can shrink the unit cell size and increase the sample rates of 3D Flash LIDAR arrays allowing or significant improvement in both range and spatial resolution. ASC is proposing to design and simulate the architecture for a high speed (2 GHz) high resolution 3DFPA, running at nearly 5 times the current sample rate (430MHz) of the 128x128, and with compact pixel geometries scalable to 1 megapixel arrays. This effort would help to push the state of the art of Flash LIDAR from 128x128 3cm resolution arrays to 1024x1024 arrays with millimeter and possible sub- millimeter resolution. In Phase II, ASC would fabricate a representative small format arrays (32x32) using the state of the art 22um fabrication process.

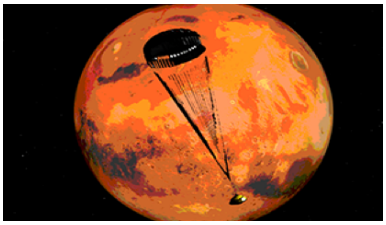
Application

Asteroid Redirect Mission (ARM) Commercial Resupply (CRS) to the International Space Station Commercial Crew Transport Capability (CCtCap) Planetary Entry Decent & Landing and ALHAT Rover Mobility and Navigation Space Situational Awareness

Non-NASA Applications

Commercial applications include collision avoidance to save pedestrians and prevent vehicle damage, Mid-Air Refueling, Surveillance, Terrain Mapping, Autonomous Navigation for unmanned ground, air and surface vehicles. The 3D maps created by the system will be useful to avoid automobile accidents and guide robots for Hazard Material Detection and Handling.

Coherent Applications, Inc.



Innovation

A laser based terminal descent sensor is proposed that will provide real-time ground-relative altitude, attitude, and velocity at high data rates to a navigation computer of a vehicle during landing on a near earth object or planetary body. The operational range of the sensor in Mars, for example, can exceed ten kilometers through touchdown, and may conceivably be a low mass, volume, and cost replacement for the Terminal Descent Sensor (TDS) on missions like the Mars Science Laboratory (MSL). The sensor is compact, rugged, and can be easily integrated with other NASA smart sensor systems coming of age, such as

the Autonomous Landing and Hazard Avoidance Technology (ALHAT) project or the Lander Vision System (LVS).

Application

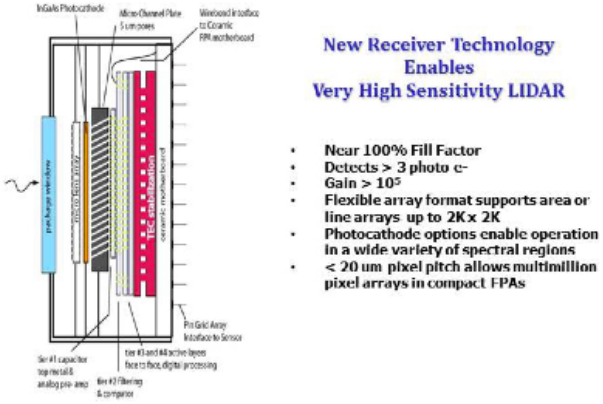
The sensor is designed for EDL applications applicable to any NASA planetary mission. It can also be used to support rendezvous and docking, asteroid capture, and terrain relative navigation on GPS deprived environments. The high data rate products produced by this sensor and the unique components developed under this SBIR can also serve earth science applications and missions, such as ice content surveying, forest canopy density and vegetation coverage, and CO2 sequestration.

Non-NASA Applications

The compact, high accuracy, high data rate measurements make this sensor ideal for many laser based remote sensing. A few examples of Non-NASA applications include topographic surveying and mapping, drone navigation in GPS deprived environments for civilian or military applications, rotary craft landing in visually deprived environments, and terrain relative navigation of smart weapon systems.

Irvine Sensors Corporation

Innovation



Uncertainty could be substantially reduced if sufficiently high resolution 3D imaging were available in real time. 3D LIDARS offer a potential solution. Current imaging LIDAR systems have limited resolutions, frames rates, frame sizes, and area search rates to support high reliability robotic missions in space. What is needed is a capability to very accurately characterize the three dimensional surfaces of space objects where landing is intended or the surfaces of space objects that are to be studied by very close proximity operations on timelines required to insure effective operations. The proposed development will extend the spatial, temporal, and sensitivity available in compact 3D Imaging LIDARS that will reduce uncertainties and insure effective operations.

Application

The proposed development of an advanced 3D LIDAR Receiver technology that will increase area coverage, image resolution, time sampling, and sensitivity SIMULTANEOUSLY and still be in a low SWaP package will find extensive use for extraterrestrial missions. Further, this technology can also provide a significant improvement to operations under conditions of uncertainly when exploited on Unmanned Air Vehicles enabling safe autonomous operation of these vehicles in the National Air Space.

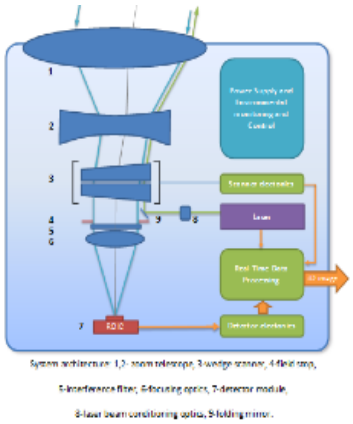
Non-NASA Applications

A key application of the technology will be extending capabilities of wide area surveillance

security systems for protection of critical infrastructure. The technology will substantially improve the capability for real-time characterization of activities in areas being monitored. The technology enables an extension of video surveillance systems to robust 3D imaging in a fully eye safe manner.

Sigma Space Corporation

Innovation



Next generation 3D imaging lidar for a wide range of space applications from orbital mapping and proximity operations of small bodies, to planetary entry, descent and landing. Low Earth Orbit operations such as rendezvous and docking, and debris search and collection would also be supported. The system architecture is modular and scalable. The design combines advanced technologies and offers performance and flexibility exceeding those of prior instruments. Its key advantage is the operation at the single photon level. It features high spatial/range resolution, wide field of view, flexible scanning, autonomous target acquisition and tracking, and measurement rates of up to several Mpix/s. It advances the state of the art by extending the dynamic range, improving the accuracy and the spatial resolution of 3D measurements and reducing the impact of such sensors on the spacecraft accommodation complexity and cost.

Application

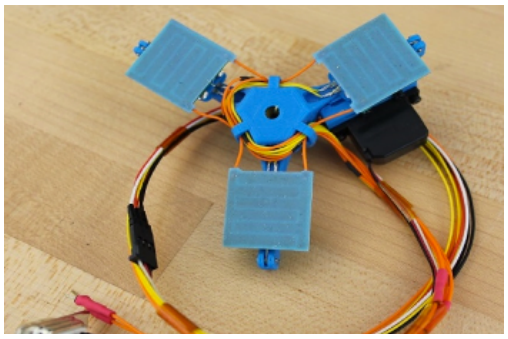
The technology developed here can be used to map the surface during descent and landing operations on a wide variety of extraterrestrial bodies, including asteroids, comets, planetary moons, and even planets. Comparable high resolution mapping from orbit about planets or moons would require appropriate increases in laser power and/or receive aperture. For these larger bodies, the scanner can be placed behind the telescope in order to significantly reduce scanner size and weight.

Non-NASA Applications

Photon-counting 3D imaging lidars can be used for safe landing of manned or unmanned drone helicopters during "brownout" or low visibility conditions. Units significantly smaller than the NASA Mini-ATM system (1 ft3, 28 lbs) are feasible since the earliest low power (3.8 mW) lidar versions demonstrated an ability to map the ground through dense ground fog from altitudes in excess of 5 km.

Robotic Mobility, Manipulation & Sampling

Somatis Sensor Solutions



Innovation

The "Electrostatic Gecko Gripper," for the industrial

automation market. This unique gripping solution overcomes the shortcomings of vacuum grippers by eliminating the need for a compressed air system and offering more rapid actuation, thus achieving significant cost savings and throughput improvements in customers' manufacturing processes. The gripper utilizes an adhesive element inspired by gecko feet coupled with an electrostatic adhesive. When the electrostatic and gecko adhesives work together, a positive feedback cycle is created that can be greater than the sum of its parts, as the gecko adhesive engages, it brings the electrostatic adhesive closer to the surface, thus increasing its adhesive force; in turn, the electrostatic adhesive helps engage more of the fibrillar stalks of the gecko adhesive. Previous experimental results have shown that the combination adhesive technology can provide up to 5.1x greater adhesion than either adhesive alone.

Application

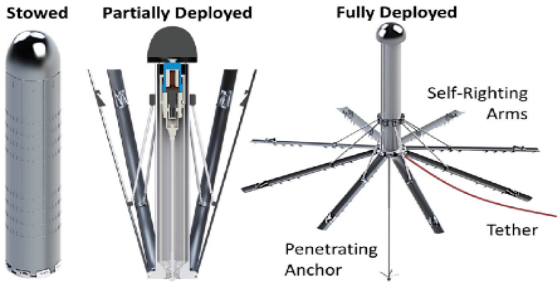
Manipulation and Sampling. Of specific relevance is the ISS Remote Inspection System (IRIS) being developed at JPL. This system utilizes gecko-inspired adhesive feet to anchor to the micro-gravity environment of the ISS. Furthermore, NASA has identified the SPHERES program as a technology platform to utilize electrostatic, gecko-based, or combination thereof for gripping surfaces in such free-flyers.

Non-NASA Applications

We have identified solar panel and glass manufacturing as the primary target markets due to the relatively versatile and expansive reach of these industries as well as the high level of interest expressed in our solution. Other potential markets include aerospace and automobile manufacturing, packaging and warehousing.

Tethers Unlimited, Inc.

Innovation



Current planetary exploration missions are quite constrained due to limited vehicle mobility. The most potentially rewarding areas for exploration will require improved mobility to access craters, gullies, skylights, and mountains. The NASA Technology Roadmap explicitly calls for tethered mobility solutions to address this limitation. The proposed ARACMO Anchor is a proven technology that has evolved from previous and existing SBIR efforts to directly meet this relevant NASA need. No other technologies exist which can quickly and effectively place a high load capacity tethered anchor at a remote location. This technology will also be valuable for other applications such as sampling, resource acquisition, permanent anchoring of structures, astronaut mobility, and aerobot anchoring.

Application

The ARACMO system will allow NASA exploration missions to extend scientific investigations in previously inaccessible terrain. It will enable rovers to explore craters, cliffs, caves and gullies. The ARACMO system may also be used for sampling, in situ resource acquisition, permanent anchoring of structures, astronaut

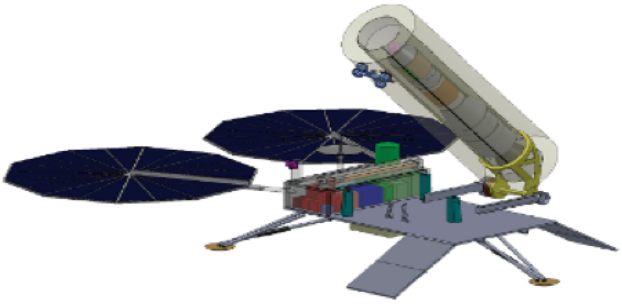
mobility, aerobot anchoring, and deployment and retrieval of systems in zero-G environments.

Non-NASA Applications
The ARACMO Anchor technology could be instrumental for search and rescue operations, soil stabilization needs, or response to natural disasters. It could provide greater mobility for military and recreational vehicles. It could also be used in the construction industry to quickly set-up anchors to stabilize structures.

Spacecraft Technology for Sample Return

Arctic Slope Technical Services

Innovation



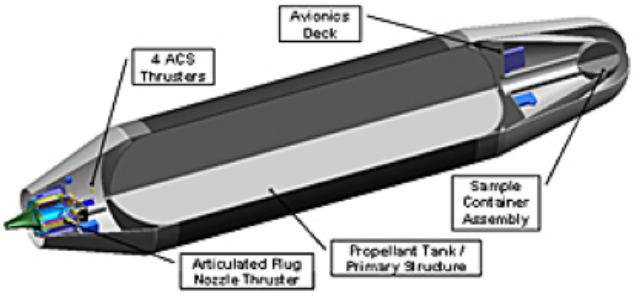
Design of an aerospike nozzle for the solid rocket motors baselined for the Mars Ascent Vehicle (MAV). The use of a truncated aerospike is offered not because of its altitude compensation characteristics, but because of its exceptionally short length for a given area ratio. F or a fixed-length vehicle like MAV, a short aerospike nozzle enables lengthening the motor case, thereby allowing the loading of significantly more propellant. In turn, this will greatly increase the payload capability of MAV.

Application
Launch Abort System (LAS) for Space Launch System (SLS)

Non-NASA Applications - Tactical missile axial propulsion

Microcosm, Inc.

Innovation



The single-stage, liquid monopropellant point-of-departure MAV concept, leverages recent component advancements resulting from the more than $500 million investment made by the Missile Defense Agency in miniature interceptor component technology development. It utilizes a depressed freezing point hydrazine propellant blend capable of long term storage below the -40° C environment currently provided by the Entry Decent Lander (EDL). Primary propulsion is provided by a patented articulated plug nozzle thruster which offers superior performance during ascent over a standard bell nozzle and being a liquid system it can be throttled and turned off and on multiple times. This operational flexibility enables

implementation of optimal guidance solutions, decreasing the required propellant load. Flexibility also enables the MAV to perform orbit adjust and ascent retargeting maneuvers as may be required due to off nominal Earth Return Vehicle performance.

Application

This technology will dramatically reduce the spacecraft mass of a sample return mission that has to lift off from any substantial celestial body. I t can be used either to reduce cost, increase the mass of the returned sample, or both. The technology will be critical for any sample return mission from any major solar system body, including the Moon, planets, or moons of other planets.

Non-NASA Applications

There is substantial interest in commercial sample return missions, for which the key issue is how much material can be returned at what cost. This technology both reduces the cost and dramatically increases the mass of the samples that can potentially be returned, which makes non-NASA sample return missions much more economically viable.

Ventions, LLC

Innovation

Low-risk, pump technology for on-board pressurization of MON-30 / MMH in Mars Ascent Vehicle. Batch fabricated in a low-cost manner using demonstrated process to realize fine-featured aerodynamic blade shapes with good structural properties. Designed at low DN numbers to utilize COTS hybrid bearings for overcoming the rotordynamic issues commonly encountered in traditional turbopump systems. Designed with integrally-fabricated, fully-shrouded rotors to eliminate tip clearance losses.

Application

The enabling technology overcomes a key challenge of providing on-board pressurization at the small-scale, thereby enabling a new generation liquid bipropellant rocket engines in the 100-5,000lbf thrust class for other NASA applications such as lunar ascent / descent missions (precursor rovers, cargo, etc.), Near-Earth-Object (NEO) missions and outer planet orbit capture and insertion.

Non-NASA Applications

Upper stage propulsion for small commercial launch vehicles. - Core upper stage propulsion for various DARPA programs. - Lunar lander propulsion for commercial entities. Orbital insertion engines and apogee kick motors for orbit circularization of commercial satellites.

Extreme Environments Technology

FastCAP Systems Corporation

Innovation

A novel solid state ultracapacitor ("ultracap") capable of reliable operation from 0°C to 300°C, with survival at a temperature range of -55°C to 350°C. When complete, the device will exceed FastCAP's current world record as the highest temperature ultracap in the world. The high power density (>1.4 kW/kg, 1kW/L) at high temperature, the proposed ultracap will enable deep space high temperature environments, enabling reduction in the weight, volume and complexity of energy storage systems, while relaxing design constraints on scarce candidate high temperature battery technologies. Importantly, the device will not exhibit the typical volatility and toxicity associated with traditional electrolytes present in current aerospace battery technologies.

Application

Energy Storage for deep space exploration missions with extreme temperature requirements (i.e. Venus Missions, Sun Missions, Lunar Quest Missions), Electric Propulsion Systems; GPS/Guidance; Deep Space Transponders and Radars; Satellites; Cube-Sats; Payload Operations; Exploration Vehicles (landers, rovers); Pyro Initiators for the stage separation of the rockets; Flight Termination Systems (FTS); Emergency Detection Systems (EDS); Peak Power harvesters from power sources such as PVs.

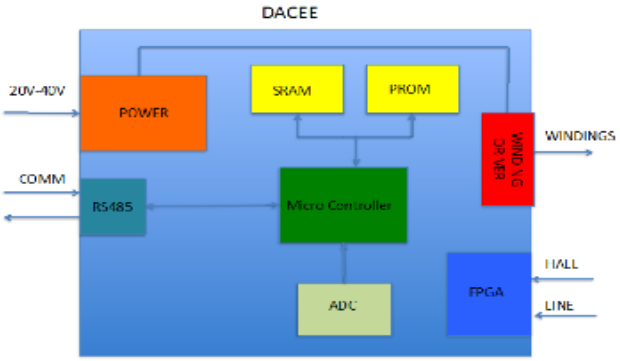
Non-NASA Applications

Geothermal drilling, well development, well monitoring and production applications, ultra high temperature and pressure (HTHP) oil and gas drilling applications, and a wide variety of high temperature defense, consumer electronics, vehicles, and commercial avionics applications.

Motiv Space Systems, Inc.

Innovation

Dual Axis Controller for Extreme Environments (DACEE). Dual Brushless/Stepper Motor Controller. 100 Krad Radiation Tolerance . Wide Temperature Operational Range (-180° C to 100° C) - Small Form Factor (~2"x3"x0.5")



- RS-485 Communications - Hall Commutation, Line Encoder Position Feedback - Design supports PID velocity and position loops.

DACEE Enables Scientific Exploration of Extreme Environments - Targeted Destinations:

Comets, Asteroids, Titan, Phobos, Deimos, Mars, Moon. - Wide temperature operation reduces heater power resources - Radiation tolerance reduces shielding mass needs - Small form factor simplifies integration into spacecraft and instruments

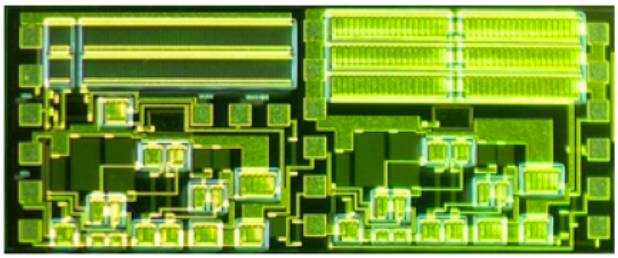
Application

Instrument Mechanisms and Actuators - Protective Cover Releases - Instrument Boom Deployments - Lens adjustments - Antenna pointing - Camera Steering

Non-NASA Applications
GEO Communication Satellite Applications - Antenna Positioners - Hinge deployments - Thruster directional drives LEO Satellite Applications - Space Station and New Venture commercial pointing systems

UNITED SILICON CARBIDE, INC

Innovation



Silicon Carbide IC developed by USCi

Radiation tolerant, extreme temperature electronics are a cross-cutting technology with broad applicability to many NASA applications and planned missions. In this program, the capability of silicon carbide (SiC) integrated circuit technology (IC) wilbe extended to meet NASA's need for extreme environment electronics. The result will be a commercially sustainable manufacturing technology for reliable, extreme temperature, radiation hard electronics.

This capability is possible due to SiC's material properties that enable higher reliability and performance in extreme environments than can be achieved with silicon and because SiC is more technologically mature than other wide bandgap semiconductor technologies. SiC based extreme environment electronics technology will both enable long term operation throughout the solar system and reduce overall system mass, volume and power due to a reduced need for temperature control and radiation shielding of electronic systems.

Application

Solar system exploration, including planned Venus In-Situ Explorer and Europa- Jupiter missions, requires extreme environment electronics. The technology is also ideal for scalable, high operating temperature, radiation hard power management and distribution and power processing units for satellites and other spacecraft. In aviation, it will enable practical implementation of distributed engine control systems for improved jet engine performance and efficiency.

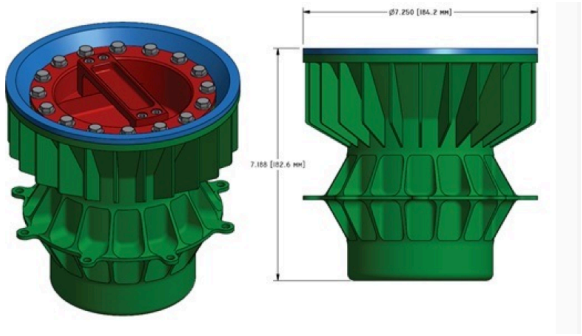
Non-NASA Applications

DoD needs extreme environment electronics for missile defense applications and advanced electronic aircraft controls. Commercial applications include advanced engine controls. Scientific applications include nuclear physics research and instrumentation for nuclear facilities. Extreme temperature electronics are also needed for geothermal energy exploration, development, and production.

Contamination Control & Planetary Protection

Honeybee Robotics, Ltd.

Innovation



Investigate Knife Edge, Shape Memory Alloy, Induction Brazing and O-Ring as a promising hermetic sealing technology which can be applied to Sample Return (SR) missions, such as the Flagship Mars SR, New Frontiers (NF) Comet SR and the Lunar South Pole-Aitken Basin SR. The sealing system will be designed to store samples of rocks, soils, atmospheric gas, ice or icy-soil. Design and fabricate a hermetic sealing canister, and test the hermeticity to achieve leak rates of 10-7 atm cc/sec He .

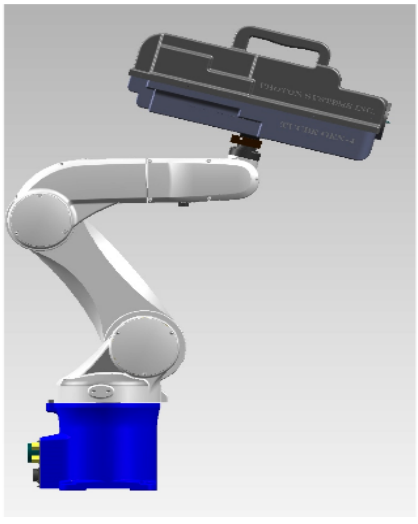
Application

Future robotic astrobiology and geology missions such as Mars Sample Return, as well as Lunar, Comet and Asteroid sample return missions will benefit greatly from the ability to hermetically seal samples in a dusty environment. These missions will require long periods of time where the samples are either in transit back to Earth, or awaiting pickup.

Non-NASA Applications

Terrestrial uses of robust hermetically sealed containers might include telerobotic inspection and sampling of hazardous materials. Tele-operated robots can go into many hazardous areas which humans cannot. These robots could be outfitted with canisters with hermetic seals which function in the presence of dirt, dust and chemicals.

Photon Systems, Inc.



Innovation

Demonstrate and validate a new, non-contact, advanced analytical method and instrumentation to detect trace levels of chemical and biological contaminants directly on spacecraft and related surfaces to comply with Contamination Control and Planetary Protection requirements. The method employs non-contact deep UV Raman and fluorescence chemical imaging and mapping methods to avoid the need for any contact with spacecraft and related surfaces, which eliminates the use of traditional sample collection methods such as swabs or other methods, which have been shown to back-contaminate spacecraft surfaces and collected samples.

This method enhances the ability to detect and identify the trace chem/bio materials with proven ability to detect materials on surfaces << 1 pg, a fraction of a single bacterial spore, with dimensions as small as 200 nm.

Application

For NASA, the effort proposed here has directly applicability to trace chemical and biological cleaning validation related to Planetary Protection not only for non- contact cleaning validation of spacecraft surfaces but also of cleaning validation of facilities to build spacecraft and store. The technology is applicable to detection of trace contamination on optical and other surfaces and is adaptable to detection of trace contaminants in liquids such as water or cleaning or processing solvents.

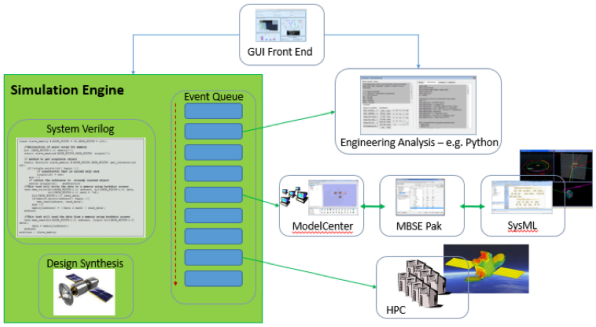
Non-NASA Applications

Non-NASA applications include chemical and biological surface contamination for the cleaning validation of manufacturing equipment and product quality testing in the pharmaceutical, food, chemical, semiconductor industries. Further applications include medical applications including hospital surgeries as well as environmental monitoring of water, air, soil, and a myriad of other applications.

Integrated Science Mission Modeling

SynaptiCAD Sales, Inc.

Innovation



Current simulation tools are difficult to scale to the requirements posed by NASA and are typically used for smaller problems. The simulators used in digital electronics design, however, offer the best possibility for adaptation to highly complex NASA systems. They are already used to simulate complex digital circuitry and process millions of events per run. They also offer integration with engineering modeling tools through interfaces designed for this purpose. This proposal will adapt such a simulator, based on the SystemVerilog language, so it can be used effectively at all stages in the design of complex systems such as satellites, robotic explorers, telescopes, and sensors.

Application

Applications include complex design projects across the spectrum of NASA Science, Human Exploration and Operations, and Aeronautics Research Mission Directorates. Initial applications will include advanced satellite systems, telescope design, and robotic exploration. A strong role is anticipated at centers that already use MBSE / ModelCenter technology (e.g. JPL, Langley). Several NASA sites already use the products and technology this proposal is based on.

Non-NASA Applications

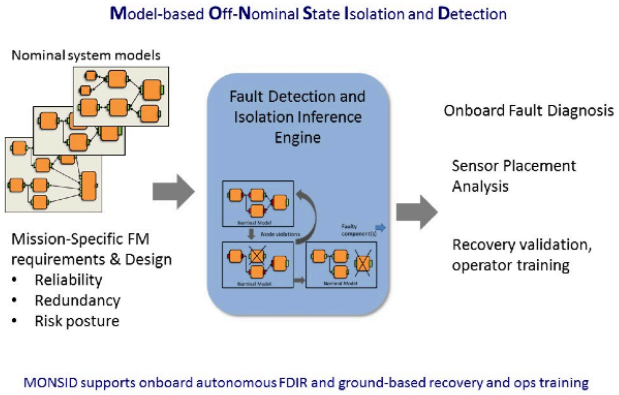
Beyond NASA, applications will be focused primarily on the aerospace and defense sector where DoD and prime contractors, such as Lockheed Martin, who have already indicated an interest in these capabilities. After establishing penetration in A&D, secondary markets such as automobiles, heavy equipment, and shipbuilding.

Fault Management Technologies

Okean Solutions, Inc

Innovation

The Model-based Off-Nominal State Isolation and Detection (MONSID) system provides robust and reliable fault management capabilities for spacecraft. The solution supports higher levels of spacecraft autonomy in maintaining operations by reducing mission outages caused by long fault recovery efforts. The system is composed of a diagnostic engine and user- supplied models (e.g. power and attitude control components). Sensed data are propagated through nominal system models. Faults are diagnosed when inconsistencies arise between sensed and modeled data. The technique does not require explicit fault modeling to detect and isolate faults. Benefits include: potential to detect unanticipated and unforeseen faults; resources and time are saved because models used for nominal operations can be re-used for FM; core software is fixed and does not grow to accommodate a growing number of faults; it can be used early in the design phase as a tool for sensor placement analyses and model verification.



Application

The MONSID system will support current and future programs on the ground, in training and recovery operations, and in space, providing onboard autonomous fault detection and isolation. The FM core diagnostic algorithms are generic and only the models are program specific. It is applicable to a broad range of NASA mission classes from near-Earth to interplanetary, as well as risk-adverse, and experimental missions.

Non-NASA Applications

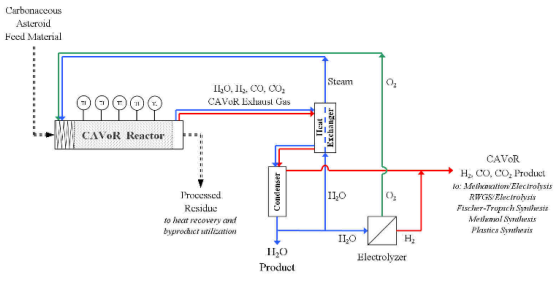
The system is well suited for spacecraft with modular HW/SW architectures. These new architectures will require updated approaches to FM and tools to support them. The MONSID system would increase availability and user adoption of NASA and industry partner products across a wider customer base including DoD labs, large and small prime contractors, FFRDCs/UARCs, and non-US aerospace organizations.

Regolith ISRU for Mission Consumable Production

Pioneer Astronautics

Innovation

The Carbonaceous Asteroid Volatile Recovery (CAVoR) system extracts water and volatile organic compounds for propellant production, life support



consumables, and manufacturing from in-situ resources in support of advanced space exploration. The CAVoR thermally extracts water bound to clay minerals and then uses the water along with small amounts of oxygen to steam reform organic matter contained in carbonaceous chondrite asteroids. In addition to water, CAVoR produces hydrogen, carbon monoxide, and carbon dioxide that comprise precursors to produce oxygen for propellant and breathing gas and to produce organic compounds including fuels and plastics. The CAVoR operates at in microgravity at temperatures of 700° to 800° C in thermally protected steel alloys at a pressure of about 1 bar absolute. The thermochemical production of hydrogen by CAVoR reduces electrical power requirements by up to 40 percent compared to combustion- based technologies for recovery of organic matter.

Application

The primary application of the Carbonaceous Asteroid Volatile Recovery (CAVoR) system is to provide a compact, high performance apparatus for the extraction and recovery of water and organic matter in support of propellant production, breathing gas, and life support. These capabilities are key to extending NASA's mission beyond low earth orbit to include long-duration space habitation, lunar, and Mars colonization missions.

Non-NASA Applications

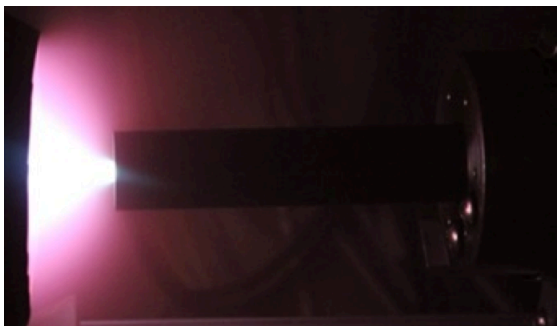
The CAVoR technology will serve the growing market for waste volume reduction and low-grade fuels resources. The device solves industrial and municipal waste challenges with minimal environmental impact. The CAVoR steam reforming technology does not require exotic chemicals or catalysts for the production of water and syngas, thereby resulting in favorable economics for low-value feed stocks.

High Power Electric Propulsion

ElectroDynamic Applications, Inc.

Innovation

The innovation proposed is a hollow cathode that integrates mitigation methods to suppress wear to the keeper. Recent advances in the magnetic topology in Hall thrusters has eliminated erosion of the thruster walls. As such the life limiting component of Hall thrusters has shifted to the cathode lifetime.



The overall goal of this proposal is to produce a hollow cathode with integrated energetic ion mitigation technology. This cathode will be tested in magnetic field environments characteristic of Hall and gridded ion engines. It will provide a good body of experimental evidence of how to successfully mitigate cathode erosion for the high powered thrusters currently under development. Additionally, an energetic ion mitigation method could be directly integrated into the cathode design for the recently proposed Asteroid Retrieval Mission (ARM) which is currently baselined to use 4-5 10 kW class magnetically shielded Hall thrusters.

Application

The direct application of long life, high current hollow cathodes is that of supporting NASA missions involving high power electric propulsion. This includes those high power missions to support human operations in space as well as aggressive space science mission. For example, an energetic ion mitigation method could be directly integrated into the cathode design for the recently proposed Asteroid Retrieval Mission (ARM) which is currently baselined to use 4-5 10 kW Hall thrusters.

Non-NASA Applications

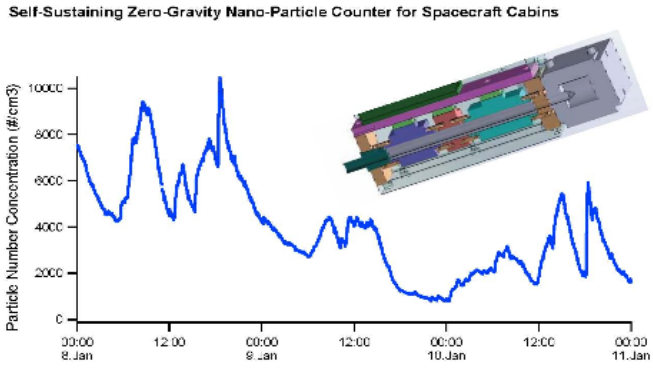
The cathode mitigation technology is generally applicable to Hall and ion thrusters used for both government and commercial satellite orbit raising, orbit transfer, and station keeping. In particular, the mitigation technology supports Air Force and other DoD onboard electric propulsion interests. The technology would also be a life extender for commercial sector satellite makers.

Environmental Monitoring for Spacecraft Cabins

Aerosol Dynamics Inc.

Innovation

Currently there are no tools to monitor the size or concentration of nanometer to submicrometer particles aboard spacecraft cabins. Yet there are many sources aboard the spacecraft known to generate particles in this ultrafine size range. This technology provides a means to make this measurement in a compact, low power unit that may be made suitable for spacecraft.



With a newly developed, self-sustaining water-based condensation particle technology, particles from the nanometer to micrometer size range are enlarged through water condensation and counted optically. Unlike other condensation-based counters, this unit recovers all of the evaporated water within the wick itself. It needs no water reservoirs, and can be operated in any orientation. All water transport is by capillary action, and gravity is not needed. Coupled with a size selection device it can provide data on mean particle size. Measurable concentrations are from 1 to 1 million particles per cubic centimeter.

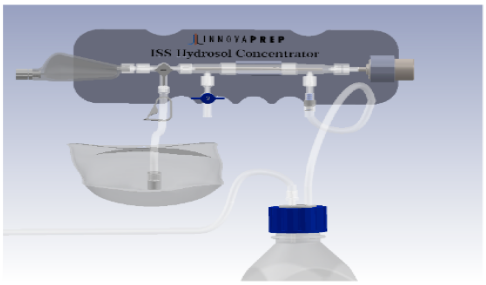
Application

NASA will use this instrument to monitor airborne particle environmental in manned spacecraft. Such data is needed (1) to establish the levels and sources of airborne particulate to which crew are exposed, and (2) to provide a signature of background levels to enable earlier detection of smoke particles from fires.

Non-NASA Applications

Because it is tippable, and emits no toxic fumes, this instrument would be uniquely suitable for measuring concentrations on moving platforms, inside aircraft, on school buses, or in indoor environments such as offices and schools. It would be used for community monitoring networks, and by aerosol research laboratories as a handy, non-toxic measurement.

InnovaPrep, LLC



Innovation

Providing safe drinking water is a critical requirement for space exploration. Complex water systems, increased microbial pathogenicity and the remoteness of the space environment make rapid, reliable methods of detecting microbial contamination a critical need. Microbial detection has taken steps forward and today detection of a single organism is possible in minutes, but development of equally important rapid concentration techniques has lagged. This proposal is to develop a rapid concentrator, based on current technologies, but designed for use in the International Space Station microgravity environment. The system will concentrate microbes from large water volumes into volumes compatible with rapid detection systems. The water is processed through hollow fiber membrane filters capturing microbes in the fiber lumens. The microbes are then eluted using a novel Wet Foam Elution process and delivered to a rapid detection system for analysis.

Application

The proposed microbial concentration system, along with a rapid detection system, will be an important tool for improved monitoring of the International Space Station and other spacecraft water supplies. The US Segment of the ISS requires analysis of 30 microbial samples in the first 90 mission days and two per month after. Further, as noted by Yamaguchi, manned missions to Mars, which may be realized within the next two decades, may further increase the need for rapid microbial monitoring.

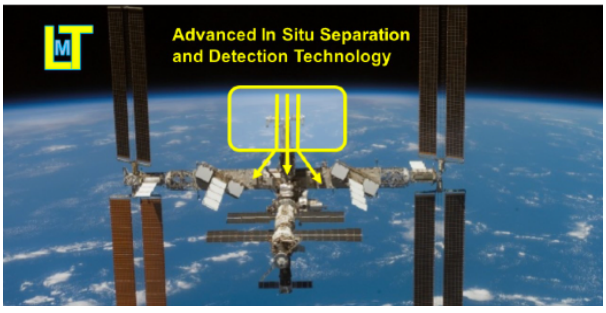
Non-NASA Applications

The proposed microbial concentration system will have application to the microbial water monitoring needs of the International Space Station and all national and international space agencies. In addition to the needs of the space agency community, many components of the technology developed in the proposed project will also have application to earth-based microbial water monitoring applications.

Leiden Measurement Technology, LLC

Innovation

Develop a portable microfludic analysis instrument for measurement of inorganic ions present in potable water supplies, thermal control system cooling water, and



human waste water. The technology will be developed to provide NASA with microfluidic analytical instrument technology in a user-friendly, compact, and automated instrument platform. Current state-of-the-art technologies will be advanced by performing a proof-of-concept demonstration of Microchip Capillary Electrophoresis with Capacitively-Coupled Contactless Detection for the rapid separation, detection and quantification of inorganic ions specified in NASA Spacecraft Water Exposure Guidelines.

Application

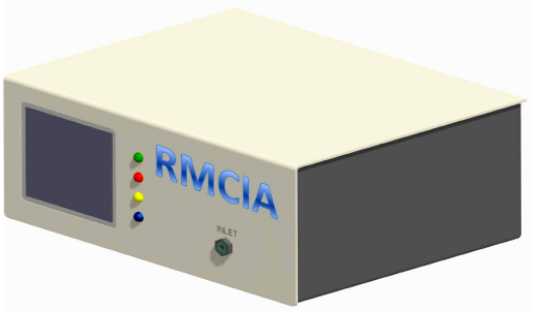
The MCE-C4D technology will be developed to meet NASA needs for water quality monitoring and analysis. The technology will serve multiple applications including potable and non-potable water analyses. The MCE-C4D technology addresses NASA Human Exploration and Operations Directorate goals by providing technology to enable the safe and extended use of the International Space Station.

Non-NASA Applications

The innovative power of our MCE-C4D system stems from automation and robustness, which greatly improves portability to allow use in remote regions across the globe. The instrument is well suited for numerous potential commercial applications where separation and of inorganic species is required including: soil analysis, biomedical diagnostics, and monitoring of contamination from process systems.

Lynntech, Inc.

Innovation



There is limited capability for water quality analysis onboard current spacecraft. Several hardware failures have occurred onboard ISS which demonstrate the need for measurement of inorganic contaminants. Monitoring capability is of interest for identification and quantification of inorganic species in potable water, thermal control system cooling water, and human wastewater. Needed attributes for such multi-ion analyzers to be used in NASA manned space exploration missions include: minimal sample preparation, use of small sample volumes, little or no need for reagent resupply, instrument of minimum size and weight, high sensitivity, accuracy and reliability, in situ calibration, and operation in microgravity and partial gravity.

Application

Direct NASA applications include the on-board water quality monitor to frequently analyze the crew water supply in order to quickly indicate if the Exploration Water Recovery System is not functioning properly. The multi-analyte capability will expand the applications to measurements on typical ionic species in humidity condensate, potable water, wastewater, byproducts of water treatment such as brines, and biomedical and science samples for space exploration missions beyond low Earth orbit.

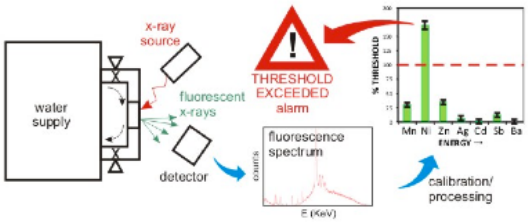
Non-NASA Applications

Successful development of RMCIA as a portable device will have a high commercial applicability to a wide range of industries where water quality assurance and control is important, such as semiconductor industries, food and drink industries, pharmaceutical industries, municipal utilities, and remote potable water production industries.

Spectral Sciences, Inc.

Innovation

Construct a persistent in-line water quality monitor to identify and quantify trace metal contaminants. The innovation is application of advanced signal processing techniques to separate the weak contaminant signals from the broad background signal due to the water.



Significance of Innovation: There is a critical need to continually monitor impurities in the water supply aboard the International Space Station in a manner that minimizes the sample volume. Existing technology can measure inorganic contaminants at concentrations established as safe in the Spacecraft Water Exposure Guidelines, but these methods are inappropriate for the ISS due to the required size and power of the equipment, the size of water sample required for testing, or some combination of these.

Application

(1) continuous in-line water quality monitor for International Space Station (2) water quality monitor for long-duration missions, such as the Manned Mission to Mars

Non-NASA Applications

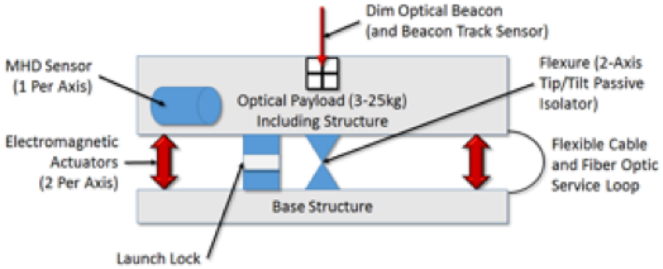
(1) screening soil and water near landfills and industrial plants (2) monitoring of industrial and nuclear facilities (3) damage assessment by first responders in the case of a spill or accident (4) water quality monitoring for developing world

Long Range Optical Communications

Applied Technology Associates

Innovation

NASA has a critical need for improved bi-directional data transmission rates from a variety of spacecraft to Earth. NASA estimates that the current Mars to Earth transfer rate of 6 Mbps might be increased to 600Mbps using a laser communication system. Beam jitter caused by spacecraft-based motion must be reduced to sub-microradian



levels to enable precision optical beam pointing. This effort will create a Stable Platform for Optical Communications (SPOC) that will host the LC collimator telescope and provide a stabilized platform to prevent the 150-microradian spacecraft disturbance environment from reaching the LC terminal. To enable stabilization, an improved, ultra-low angular noise Magnetohydrodynamic Low-Frequency (MHD-LF) sensor will be developed. The proposed sensor will have low power and high reliability that will be demonstrated by producing prototypes in Phase I. The follow on effort will develop the SPOC, a 0.5 microradian residual motion stable platform, for programs like DOT.

Application

Beginning with a NASA funded Phase I SBIR, ATA developed the stable platform concept that serves as the basis for the laser comm terminal that NASA will be flying on the LLCD and LCRD programs. Similarly, ATA's proposed Stable Platform for Optical Communications (SPOC) and Magnetohydrodynamic Low- Frequency (MHD-LF sensor could host the laser collimator for Deep-Space Optical Terminal (DOT) program, which seeks to implementlong-range laser communication to and from Mars and beyond by 2025.

Non-NASA Applications

DoD programs and companies for laser comm programs. Opportunities to apply the proposed platform technology exist with the Air Force's Space Laser Communication Terminal (SLCT), DARPA's Laser Weapon System Module (LWSM), Lockheed Martin's Space Optical Tracking (SpOT) facility, the Navy's Laser Weapon System (LaWS), and the Marine's Ground Based Air Defense (GBAD).

G. A. Tyler Associates, Inc dba the Optical Sciences Company

Innovation

The principal innovations are (1) Laser Guide Star Adaptive Optics (LGS AO) for the ground-based receiver and (2) Linear Mode Photon-Counting (LMPC) sensors that can be used for the lasercom signal, the AO Wave- Front Sensor (WFS) and the space receiver. Preliminary calculations in the Technical Objectives section suggest both LGS AO and LMPC technologies will be needed to leapfrog the current SOA. Use of an existing space-operating laser is planned.

Application

The specific areas we address are the three photon-counting areas listed in Photon Counting Near-infrared Detectors Arrays for Ground Receivers, Photon Counting PPM Digital Ground Receivers, and Photon Counting Near-infrared Detectors Arrays for Flight Receivers.

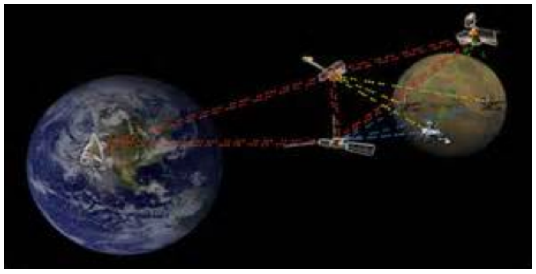
Non-NASA Applications

The prototype lasercom system in this proposal has applications in the commercial world. The same low-power laser system with LGS AO and LMPC can be used to perform long-range laser communications through the atmosphere for airborne systems on Earth for

commercial customers. Raytheon's strong commercial sector should help us make that transition to the commercial communications world.

Polaronyx, Inc.

Innovation



For future NASA's deep space missions, high efficiency and high power pulsed fiber lasers have been considered to be an enabling technology to build high power transmitters. The next generation pulsed fiber laser requires lightweight, compact, and space qualifiable modules. I t should operate at high pulse repetition rate (0.4-400 MHz), has a transform limited spectral width (<0.1 nm) at 100 W average output power and >1 kW peak power, high extinction ratio (>33 dB), 8 ns pulse width, high OSNR (>45 dB), and good pulse shape.

This is a novel approach to resolve the issues of pulse distortion and nonlinear effects (SBS, SPM, and SRS) and to achieve high efficiency (25%), high power (100 W), high PRR (0.4-400 MHz), high extinction ratio (>33 dB), in collaboration with Lawrence Livermore National Laboratory (LLNL). Our success in developing short pulse high power/energy fiber laser for NASA and other government agencies provide a solid foundation.

Application

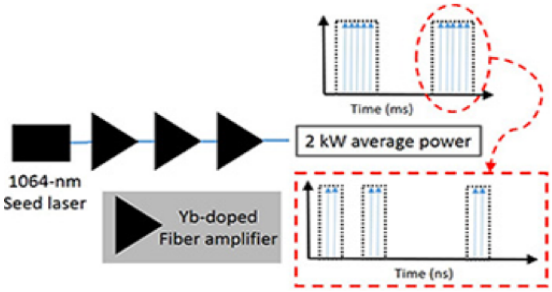
The proposed short pulse high power fiber laser approach can directly apply to NASA's deep space communications. It can also be used in other applications, such as space, aircraft, and satellite applications of LADAR systems and communications.

Non-NASA Applications

High power fiber lasers represent the next generation of critical optical components needed to build the coherent optical communications of the future and cable TVs that will deliver increased communication bandwidth and improved Quality of Service (QoS) end users. The market for the application is growing and will be of great potential of hundreds of millions market.

Q-Peak, Inc.

Innovation



A short pulse, arbitrary repetition rate fiber laser system at the kW-class average power levels is proposed to be the laser transmitter for a free-space long range telecommunications system. The laser transmitter supports data transmission rates up to 50 Gb/sec while simultaneous offering pulse position modulation and a targeting/beacon mode. The laser transmitter allows kW-class average powers while

generating modest peak powers in order to mitigate nonlinear effects. These nonlinear effects currently limit the average output powers of fiber laser systems operating in the 10s Mb/sec regimes.

Application

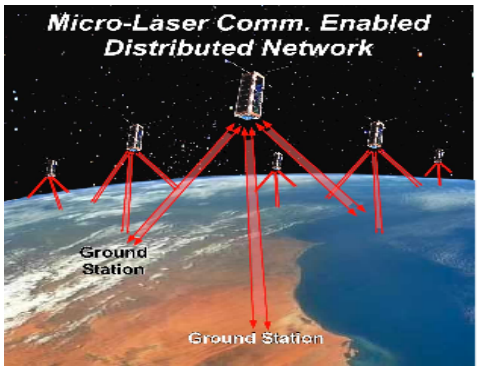
The application is for free-space communications in support of the NASA JPL facility. This can either be in the form of a geo-stationary satellite or space satellite communications with ground-based laser transmitters and receivers, which may not be at the same physical location.

Non-NASA Applications

Short pulse, arbitrary waveform, kW-class average power laser technology may open up new application spaces in directed energy and laser-based manufacturing.

Vescent Photonics, Inc.

Innovation



Design, test, and deliver ultra-low Size, Weight, and Power (SWaP) Micro-Laser Communications (MiLC) modules for high bandwidth (> Gbps) free-space data links. These modules will be enabled by unprecedented electro-optic (EO), non-mechanical laser beamsteerers (up to a 120o ? 120o field-of-view possible). Eliminating all moving parts will reduce SWaP and cost, increase lifetime and reliability, and simplify the system. High bandwidth communication links are needed between satellites and ground stations, inter-satellite, and from ground based rovers to satellites. One possible lasercom module will fit within a few cubic inch volume, require less than 1W of power and be able to provide ground station tracking (including orbital motion and jitter correction). As advanced scientific instruments burden data loads and spacecraft payloads become increasingly valuable, to keep the information flowing becomes even more challenging. Addressing this need is the focus of this effort.

Application

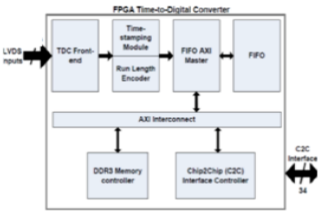
i) A LEO-T (ISS) direct-to-ground capability that would fly in 2019, ii) incorporated into an iROC demonstration flight circa 2020, iii) dramatically increase the downlink data rates from miniature satellites such as cube-sats, and iii) be used as a surface communications asset such as the 2020 rover application wherein it could provide a high bandwidth optical uplink.

Non-NASA Applications

Applications include: last-mile telecommunications environments in urban setting, for field-deployable high-definition video systems for newscasters and sports casters , a variety reconfigurable, low-cost, commercial high-bandwidth data links, satellite relay networks, surveillance systems, and satellite imagery.

Voxtel, Inc.

Innovation



A multi-channel FPGA based time-to-digital converter (TDC) is needed to process the output from single photon focal plane arrays used in lasercom. Leveraging an existing 64-channel design shown capable of better than 30 ps. time resolution and 256 channels with 120 ps time resolution, scalable 512 (threshold) and 1024 ((objective) TDCs, with optional multi-core image processor, will be developed which can process and transmit data continuously.

Application

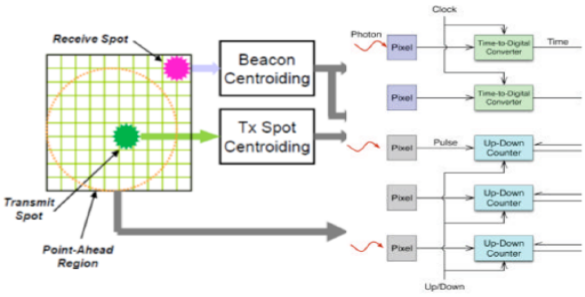
Freespace Optical Communication, charge particle detectors, Photon Counting, Laser Radar (LADAR), LIDAR, and time-resolved imaging applications.

Non-NASA Applications

Automotive LADAR, LIDAR, altimetry, time-resolved spectroscopy, fluorescent decay measurements, single photon detectors, auto- and cross-correlation.

Voxtel, Inc.

Innovation



To satisfy NASA deep-space communications needs, a readout integrated circuit (ROIC) optimized for single-photon counting (SPC) freespace optical communications will be developed, which is optimized for acquisition, tracking, ranging, and reception of the 1064 nm - 1570 nm optical radiation used for freespace optical links. The ROIC will allow simultaneous recovery of photon time of arrival and spatial localization data that can be used for lasercom optical links, data recovery, and range measurements, even in the presence of high photon flux rate objects in the field of view.

Application

Freespace Optical Communication, charge particle detectors, Photon Counting, Laser Radar (LADAR), LIDAR, and time-resolved imaging applications.

Non-NASA Applications

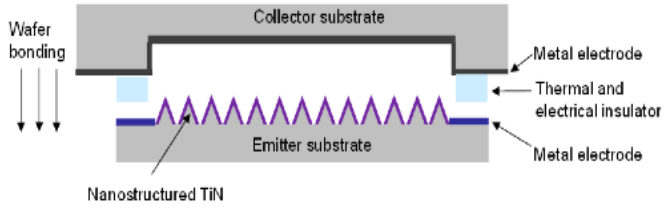
Automotive LADAR, LIDAR, altimetry, time-resolved spectroscopy, fluorescent decay

measurements, single photon detectors, auto- and cross-correlation.

Solid-State Thermal-to-Electric Power Generation

Nanohmics, Inc.

Innovation



In space exploration missions where photovoltaic power generation is inadequate due to a lack of sunlight, like Cassini or Voyager, and for missions with moderate power draw and increased mobility requirements, like Curiosity, thermal-to-electric power generator systems using radioisotopes as heat sources provides NASA with a viable solution. The proposal is to develop a novel high efficiency thermionic thermal-to-electric converter (TTEC) using nanostructured low-work-function emitters capable of high current thermionic electron emission. The emitter material employed in the proposed TTEC device allows the device to be operated in harsh and high temperature environment. In addition, precision microfabrication techniques will result in a reliable sub-micron gap between the emitter and collector of the TTEC device, which will mitigate the challenges associated with space charge limitations and further enhance thermionic emission current and energy conversion efficiency.

Application

The successful development of high efficiency thermionic power generator will improve energy conversion efficiency, specific power, and life time of RTGs power supply system, which will benefit to the W-MW power supply systems for NASA deep space exploration missions where photovoltaic power generation is inadequate due to a lack of sunlight, like Cassini or Voyager, and for missions with moderate power draw and increased mobility requirements, like Curiosity.

Non-NASA Applications

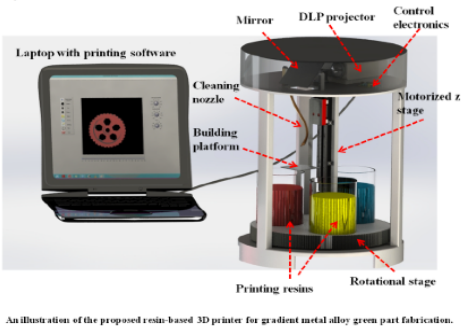
Several commercial opportunities are opened-up with high efficiency thermionic power generator, that including concentrating solar power generator system and waste heat harvesting system. The technique of nanostructured emitter with low effective work function can be applied in electron emission devices such as field emission displays and vacuum microelectronic devices.

Advanced Metallic Materials & Processes Innovation

AlphaSense, Inc.

Innovation

1) Gradient metal alloy structures possess multi-



An illustration of the proposed resin-based 3D printer for gradient metal alloy green part fabrication.

functional properties that conventional monolithic metal counterparts do not have, which can potentially change the paradigm of material selections and mechanical designs to enable more efficient space vehicles to be built;

2) Current laser-based additive manufacturing techniques for gradient metal alloy structure fabrication is time-consuming, expensive, and difficult to control.

3) The proposed resin- based 3D printer provides a significantly faster and cheaper solution for the gradient alloy fabrication.

Application

The proposed printing tool will support NASA Space Launch System to create gradient metal alloy structures with superior mechanical properties, and to build more efficient space vehicles.

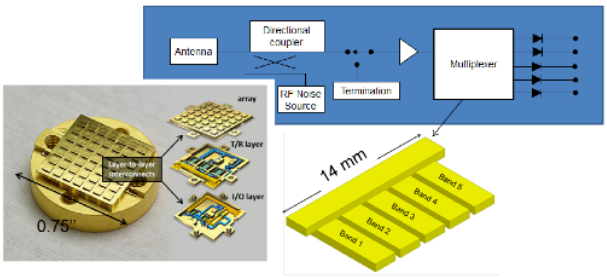
Non-NASA Applications

Used in various military and civilian market sectors for quick prototyping and low- volume productions of parts with complex shapes and configurations. The tool is highly flexible, and allows the user to produce polymer, ceramic and metallic parts directly from a digital 3D model file to significantly reduce the tooling requirements and shorten the turnaround time.

Novel Spectroscopy Technology & Instrumentation

Nuvotronics, LLC

Innovation



PolyStrata® coax and waveguide can effectively replace bulky machined waveguide components. The integration of MMICs enables miniaturization of complete millimeter wave systems. These reductions in size and weight are critical for small satellite and CubeSat applications. Innovative filters, specifically multiplexers and G band module development, coupled with technology advancements in mmWave LNAs and diode detectors, facilitate direct frequency detection radiometers. This eliminates the need for a mixer stage and its associated power consumption and further reduces system size and weight. Over the years NASA and JPL have invested in MMIC development specific to mmWave radiometry

Application

Compact G Band radiometer is applicable to small satellite applications such as CubeSat Hydrometric Atmospheric Radiometer Mission (CHARM). Potentially, a series of small satellites operating in a constellation would provide increased coverage and revisit time. Missions similar to Surface Water and Ocean Tomography (SWOT), where millimeter wave

radiometers provide vital information regarding water vapor content, to calibrate the larger altimetry system, could benefit.

Non-NASA Applications

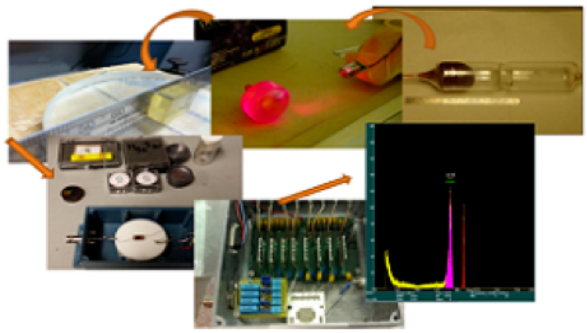
Millimeter wave radiometers are commercially used for security imagining systems. While the bulk of imaging systems occur at W band frequencies, there is a trend toward utilizing the upper mmWave and sub mmWave regions for increased resolution.

Technologies for Planetary Compositional Analysis & Mapping

Brimrose Technology Corporation

Innovation

Key challenges for modern day nuclear instruments for planetary missions is to have a dual gamma-neutron detector that satisfies highly desirable nuclear radiation detector properties such as energy resolution, efficiency, high radiation tolerance,compact & light weight. No current semiconductor / scintillation detector satisfy these features simultaneously. The development of a dual gamma-neutron spectrometer based on a new class of compound semiconductors; mercurous halide materials that address most if not all the current limitations mentioned and thus deliver breakthrough advances to existing technologies. Encouraging detector responses from Hg2I2 to both gamma and alpha particle incident radiations have been obtained.



Hg_2X_2 based multiple radiation detection spectrometer development

Application

The proposed mercurous halides-based nuclear instrument can be used onboard NASA's orbiters and landers for space planetology. Specifically, it can be used to determine surface and sub-surface composition of planetary bodies via both gamma spectroscopy and neutron spectroscopy.

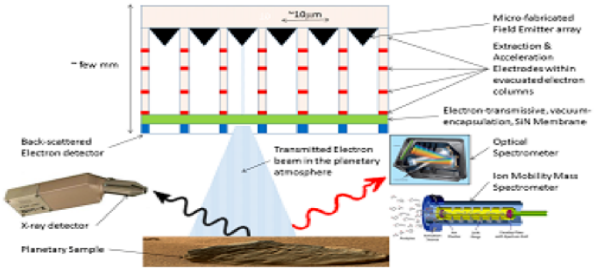
Non-NASA Applications

The proposed mercurous halides-based spectrometer can also be used for many applications such as medical imaging (SPECT, PET, Spectral-CT) as well as security and surveillance, both hand-held pager form device as well as baggage scanner.

ChromoLogic, LLC

Innovation

To date, miniaturizing scanning electron microscopes has been a goal for developers of planetary instruments. However, an in situ electron microprobe instrument has never flown. This proposal is to develop a



Multifunctional Environmental Digital Scanning Electron Microprobe (MEDSEM) instrument. MEDSEM will be capable of delivering high-energy electron beams into planetary atmospheres without the need to vacuum-encapsulate the samples, thus minimizing the size and weight of the instrument, and eliminating cumbersome sample prep and handling. MEDSEM's 2-d array of individually addressable electron probes will simultaneously generate a wealth of spatially-mapped compositional information, including X-ray Fluorescence, Backscattered Electron Spectra, Optical Spectra and Mass Spectra.

Application

Rover or Lander-based in situ planetary exploration instrument for landed missions to the moon, Mars, Venus and Europa. MEDSEM will be transported to the observation location by lander or rover arm. Once in position, MEDSEM generates high-energy (10-30keV) electron beams that impact the surface material (solid or liquid) and generate x-ray fluorescence (XRF) spectra. Additional detectors/instruments such as a backscattered electron detector and a mass spectrometer can be operated simultaneously.

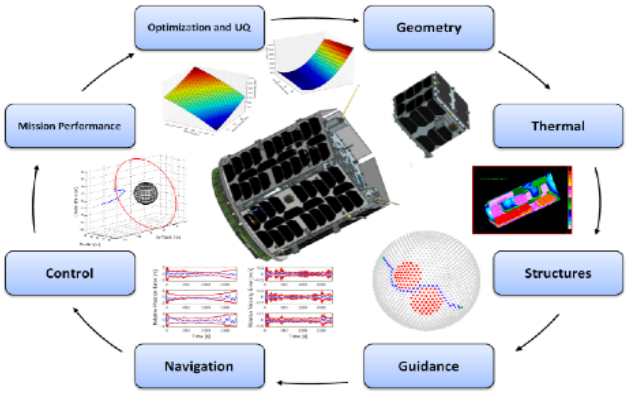
Non-NASA Applications

On earth, MEDSEM fills the need for rugged and reliable field-portable instruments. MEDSEM's low size, weight, and power will be desirable for remote geological studies, environmental monitoring and oil exploration. Additionally, MEDSEM's low cost and portability (relative to a scanning electron microscope) will provide opportunities for demonstrations and research at the K-12 and college level.

Computational Simulation & Engineering

M4 Engineering, Inc.

Innovation



Modeling and simulation technologies have assisted in the analysis and development of many complex, integrated systems. More specifically, the field of multi-disciplinary analysis and optimization (MDAO) has taken advantage of many of these technologies. Some of these technologies include design space exploration, variable-fidelity capabilities, and uncertainty and risk analysis. When considering integrated spacecraft systems, some of these challenges take the form of 1) minimizing vehicle cost, 2) reducing mass, 3) increasing propulsion efficiency, and 4) decreasing the likelihood of mission failure. Due to the fundamental competing nature of the ideal solutions to these challenges, the interdisciplinary effects of each of these objectives present an even starker picture. The current effort seeks to improve the state-of-the-art by developing a tool for the optimization of multidisciplinary analysis and performance models for complex spacecraft systems.

Application

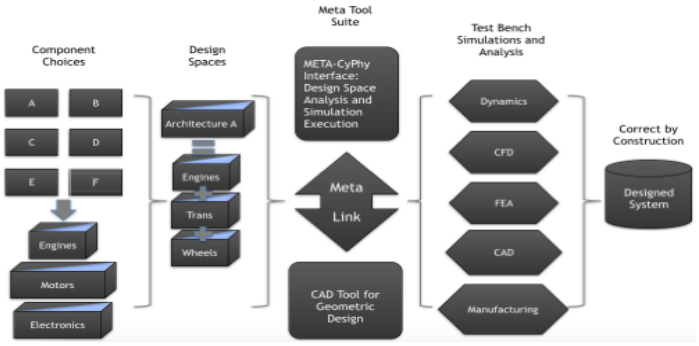
Potential NASA applications will include the use of the developed software with any complex integrated space system. Additionally, due to the modular nature of the tool and the use of widely available commercial software many different applications could be studied across most, if not all, of the NASA centers.

Non-NASA Applications

The development of an integrated multi-disciplinary analysis and optimization tool leveraging commonly used commercial software is expected to find wide application to many products. Examples include aerospace/defense, turbomachinery, automotive and alternative energy applications.

MetaMorph, Inc.

Innovation



A novel methodology is being proposed for exploration, and optimization of complex multidisciplinary systems. The proposed methodology is in stark differentiation from the traditional approach of hand-crafted and decoupled discipline specific models that are tied together via an optimization engine with "function-calls". The proposed methodology, implemented in open source OpenMETA tools developed with significant DoD investment, utilizes integrated performance models that capture behavior of components, and automatically composes discipline-specific performance models for systems from architecture models.

Application

Modeling of NASA extra-planetary explorer subsystems. Rapid evaluation of system architectures and parameters. Satellite Systems Design. Evolution of a systems concept, based on requirements to a fully detailed system design.

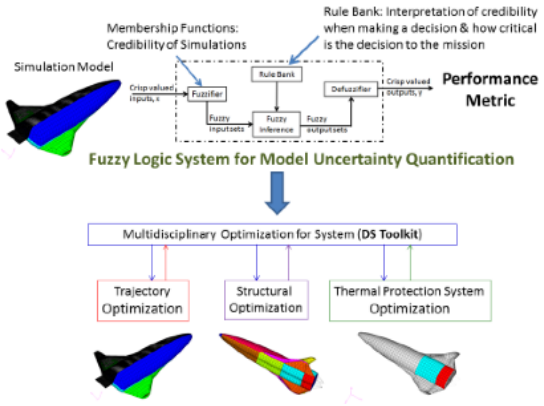
Uncertainty quantification: UQ is needed for any critical system that NASA operates. Extending UQ in a cost effective manner to all designs will improve confidence for mission critical systems

Non-NASA Applications

Aerospace: Rapid analysis of requirements and mapping to feasible aircraft architectures can help to reduce system costs for aircraft. Automotive: Modeling of product line architectures and optimizing system design to marketplace requirements will be a valuable addition to automaker's toolbox. Electronics: working modular mobile phones and modular phone components.

Michigan Engineering Services, LLC

Innovation



Entry vehicle design and aircraft design are just two examples of systems that are of interest to NASA, requiring interactions and exchange of information among multiple performance disciplines. Since any computational optimization process relies on simulation models for identifying the impact of design changes in meeting performance expectations and improving metrics of goodness, it is essential that the uncertainty quantification of these models is captured by the optimization. The proposed research will develop within an existing multidisciplinary optimization framework the ability to consider the credibility of the models and of the simulations used for evaluating the performance requirements and the performance metrics during the analysis. Subject matter experts will be able to identify the credibility of each simulation, while decision makers will be able to provide their input in linguistic format on how to interpret the credibility scores when making design decisions.

Application

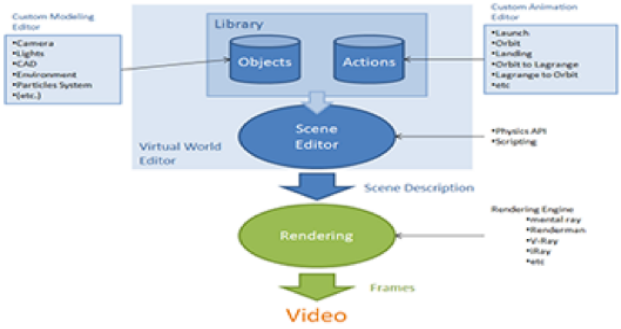
The proposed development will be applicable to all NASA Programs for conducting optimizations while accounting for uncertainty quantification associated with the credibility of models and simulations. Subject matter experts will identify the credibility of each simulation. Decision makers will provide input in linguistic format on how to interpret the credibility scores when making design decisions. It will also be possible to consider how critical each decision is to the success of a mission.

Non-NASA Applications

The proposed new approach for multidisciplinary optimization does not exist in any form in any of the current commercial or open source codes will be developed. Therefore it will be possible to promote the new developments to the shipbuilding, automotive, aircraft, space, and the military ground vehicle sectors.

Tietronix Software, Inc.

Innovation



NASA has identified a need for a tool that will give a non-expert the ability to quickly create animation of a mission scenario. This type of depiction can be important during a mission's development phase. Animation can show things that are not possible to see in the physical world and can help explain difficult concepts. Animation allows visualization of the mission without having to understand all the physics required. Currently, development of animation sequences is an involved process

requiring specific experience and tools. Our proposed innovation is to develop a set of tools that can be used by a non-expert to build a virtual mission scenario that can be used for analysis, presentations and outreach. We will create a method for developing a collection of elements (objects, actions) with initial focus, space mission specific. The toolset will have elements that have the animation expertise incorporated. This will reduce the need for the user to have animation experience.

Application

The realistic depiction of the evolution of a mission is an important tool during a mission's development phase. As planners build presentations to communicate and review mission concepts, a tool that provides the ability to build realistic animation will increase their effectiveness and efficiency at this early stage. The resulting animation can help understand the temporal connection between actions and increase discovery of inconsistencies or issues in the early stages of mission development

Non-NASA Applications

DoD environment - building mission scenarios for training and planning, troop deployment, securing a building, etc. For the oil industry an example could be drilling operations: sending the pipe into the earth, adding additional pipe, capturing a core sample, etc. The tool will include methods to describe how digital elements can be created and added to the editor for use in these industries.